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PALEONTOLOGY VERSUS GENETICS[1]

By Professor HENRY FAIRFIELD OSBORN
THE AMERICAN MUSEUM OF NATURAL HISTORY

AN interesting coincidence in the history of observation and speculation upon the nature and causes of evolution is found in the life studies of William Bateson and of the present author. In the years 1879 to 1882 Bateson was a student in the University of Cambridge. After an early zoological and embryological training he began an intensive study of variation as shown in recent osteological material, continued for a while in the biometric school and then became founder of the school of genetics. In the year 1879 the present author at the age of twenty-two was in Cambridge studying embryology under Balfour; he then took up studies in comparative anatomy and with Scott founded a new school of vertebrate paleontology.

[1] This article is an abstract of two addresses: "Bearing of Titanothere Researches on the Principles of Recent and Adaptive Radiation of the Mammals," American Philosophical Society, April 24, 1930; "Bearing of Titanothere Researches on the Principles of Mechanical Evolution," National Academy of Sciences, April 29, 1930.

William Bateson's theories and conclusions became increasingly negative; in 1893 he wrote: "If the study of variation can serve no other end it may make us remember that we are still at the beginning, that the complexity of the problem of specific difference is hardly less now than it was when Darwin first showed that natural history is a problem and no vain riddle."[2] In his presidential address of December 28, 1921, speaking as a geneticist, he made the following declaration:

> Discussion of evolution came to an end primarily because it was obvious that no progress was being made. We became geneticists in the conviction that there at least must evolutionary wisdom be found. When students of other sciences ask us what is now currently believed about the origin of species we have no clear answer to give. We can not see how the differentiation

[2] William Bateson, "Materials for the Study of Variation Treated with Especial Regard to Discontinuity in the Origin of Species," p. xii, London, 1894.

into species came about. Variation of many kinds, often considerable, we daily witness, but no origin of species. But that particular and essential bit of the theory of evolution which is concerned with the origin and nature of *species* remains utterly mysterious. The claims of natural selection as the chief factor in the determination of species have consequently been discredited. Our doubts are not as to the reality or truth of evolution, but as to the origin of *species*, a technical, almost domestic, problem.[3]

Osborn began paleontological studies in 1877 and more intensive research in the year 1890. On June 30, 1900, he succeeded Marsh as vertebrate paleontologist of the U. S. Geological Survey and at once began a most intensive geologic and biologic research on the evolution of the family of odd-toed ungulates known as Titanotheres from a name applied by Joseph Leidy to the jaw bone of *Menodus* discovered in 1846. The monograph on the Titanotheres covered twenty-nine years of research and exploration in New Mexico, Colorado, Utah, Wyoming, South Dakota, Montana, the Gobi Desert, Burma and the Balkans. The evolution of the Titanothere hereditary germ has accordingly been followed over a period estimated at ten million years from *Eotitanops* to *Brontops*. Comparison is made with the family tree of the odd-toed ungulates known as Perissodactyls showing the adaptive radiation of nine families and thirty-five subfamilies as compared with the Titanotheres which within a single family include twelve subfamilies, twenty-six genera and one hundred and six species, many of which are arrayed in close phylogenetic order.

This affords an unprecedented opportunity to contrast the zoological concept of Linnaeus of contemporaneous species with the modern paleontological concept of the origin and succession of species, subfamilies and families observed in close detail through long periods of time. Each minute part of many organs has been examined and precisely measured from its origin as it comes from the germ-plasm to its increasing importance into what may become an absolutely dominating character of the organism. This progression or retrogression is absolutely continuous and invariably definite and determinate rather than fortuitous. Characters rise and fall under twelve principles, three of which have been absolutely confirmed in the course of preparation of this monograph. The close analysis of thousands of separate characters gives us an entirely new concept of the origin of the "ascending mutations" of a genus. Inasmuch as every single one of the thousands of characters in the dental and skeletal mechanism is independently evolving, although constantly interrelated with all the other characters, a species is defined by one or more characters which reach a conspicuous stage either of progression or of retrogression. This is as true of paleontologic as of zoologic species, although in the latter case our definition is according to the eyes of Linnaeus and of Darwin, whereas in this paleontologic monograph we trace back to their origin the inconspicuous antecedents of each specific character.

It happens in the odd-toed ungulates such as horses, rhinoceroses and Titanotheres as well as in all other fossil mammals that conspicuous specific characters mostly include *allometrons* or changes of proportion, reduction or enlargement, and *rectigradations*, adaptively arising in new characters. Thus Leidy, Cope and Marsh independently divided Eocene horses by their successive rectigradations and allometrons.

In the Titanotheres, moreover, we enjoy the unparalleled opportunity of discovery that a genus consists not only of its visible generic characters but of invisible potential characters in the germ which may lie dormant for hundreds or thousands of years until they emerge. Moreover, each genus is characterized by different rates of velocities in the progression or retrogression of the thousands of characters which are embraced in its hereditary germ. For example, the horn and teeth rectigradations are hurried forward in one generic or subfamily phylum while they are closely guarded within the germ-plasm of another generic or subfamily line dwelling in the same geographic region. These origins of rectigradations are controlled by ancestral or potential heredity, whereas the origins of allometrons or changes of proportion respond directly to adaptive changes in environment.

The evolution of the Titanotheres has little to say about physical or chemical adaptations, but it gives us the most thorough and profound insight we have ever gained into mechanical adaptations. Altogether twelve principles are observed, the first nine of which are as follows: (1) principle of progression, development, of most useful mechanisms; (2) converse—retrogression, degeneration, of least useful mechanisms; (3) principle of compensation—gain of certain mechanisms compensated by loss of other parts; (4) principle of economy of mechanisms, related to principle of compensation; (5) principle of mechanical adaptation through ontogenetic or phylogenetic acceleration; (6) principle of mechanical adaptation through ontogenetic or phylogenetic retardation; (7) principle of mechanical autoadaptation of the individual, during ontogeny; (8) principle of coordination, correlation, coadaptation, of all the mechanical parts, ontogenetic and phylogenetic; (9) principle of organic selection of races which show highest powers of coincident mechanical autoadaptation and hereditary mechanical adaptation.

[3] William Bateson, "Evolutionary Faith and Modern Doubts," an address delivered on December 28, 1921, printed in SCIENCE, 55: 55–61, January 20, 1922.

Several of the above principles have been more or less fully known by anatomists, some of them reaching back of the time of Aristotle as treated in his "Physics" and in his "History of Animals." But the following three principles (10–12) are those which are first demonstrated in the Titanothere monograph although previously adumbrated in the author's earlier researches on the teeth of the Eocene primates and of the horses and rhinoceroses: (10) principle of allometrons, or adaptive changes of proportion in all the hard parts of mammals; (11) principle of rectigradations, or adaptive origins *versus* fortuitous or random origins of new characters; (12) principle of potential heredity, predetermination or emergence of rectigradations.

Whatever may be true as to fortuitous mutation and as to chance or random variation in chemical and physical adaptations, the mechanical evolution of the Titanotheres, a unique record of ten million years in the development of the Titanothere germ-plasm, shows absolute continuity in every single organ examined. There is not the slightest trace of discontinuity or of random origin.

Thus it may be claimed that the Titanothere monograph solves the chief principles involved in the origin of "ascending mutations," species, genera, subfamilies, etc., as displayed in the hard parts of mammals. There is a firm undeviating orthogenetic order in the entire animal mechanism. There is a phylogenetic continuity of germinal adaptation and reaction in response to secular changes of habit and of environment.

DUAL NATURE OF PHYSIOGRAPHY[1]

By Dr. WALDO S. GLOCK

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IT may be held axiomatic that we live in a world which is active, dynamic and changing, in a world where energy is by nature more important, more universal, than matter. Causes arising from the flow of energy are elusive and difficult to formulate into natural laws; they seem to border too much upon the abstract. Effects impressed on matter are as a rule clearly visible and lend themselves to description, measurement and comparison. They are above all concrete. Therefore it is not wholly strange that physiography has developed to a great extent in the matter of description and interpretation of land forms.

However, physiography possesses a dual nature in causes and effects, in active forces and passive results. Geodynamics (even if necessarily modified by the word surficial) appears to be a good name for the study of those processes—active, dynamic, progressive—which are constantly at work molding the surface of the lithosphere. In contrast, geomorphology studies the physiographic products wrought by those same processes. Formal treatment of the subject, physiography, actually resolves the dual nature into two view-points, the one looking at the science in the light of activity, the other, of passivity. There remains the task of bringing out the contrasts between them.

GEODYNAMICS—THE ACTIVE PHASE

The so-called processes represent the forces at work, while the detailed surface features appear as the direct results; this is rather common knowledge. It is the attitude of approach and the method of treatment that may be radically new and different. In this case we refer to the dynamic view-point, which considers a stream to be the dominant factor in a fluvial environment, which accentuates the forces at work and represses the resultant products to mere incidents in the constant flow of energy. The stream, in fact, is the permanent, concrete reality of a situation. Geodynamics adopts the active view-point and seeks to analyze and understand intimately the physiographic processes, all the while cognizant of the fact that they are now and have been in the past at work on the land surfaces. This active phase of physiography contrasts vividly with the ordinary and purely passive study of earth form. The one is dominantly analytical and causative, the other descriptive and interpretative.

At first sight process and result depend vitally upon each other, since they are related as cause is to effect. They seem, indeed, to be inextricably interwoven—a slight variation in one either causes an equivalent change in the second or else is followed by a consistent response. These intimate relations may suggest of necessity a lack of reality in the dynamic view-point.

The absolute interdependence of process and product should not be assumed too strongly until another idea is considered. Let us imagine a comparatively resistant rock stratum forming a shoulder where it crops out on a valley wall. That stratum when first uncovered at the bottom of the valley no doubt influenced the rate of erosion and perhaps the exact position of the stream, but it did not alter or influence

[1] The work for this paper was carried on with funds made available by the research committee of the Graduate School of the Ohio State University

the fundamental nature of the agent or the characteristic activities whereby it pursued its habitual tasks. Corrasion and transportation, as processes, were not changed. Running water works on all rocks, hard and soft alike, and it is not the fault of the water if the hard rock is etched into relief.

Various streams do their work under a given (humid) climate in much the same manner almost or quite independent of underlying rock in a dynamic sense. They obey certain laws of their own, perform highly characteristic tasks and create a fluvial environment wherein the land surface responds to the sculpturing activities of the agent. It would seem reasonable to conclude, then, not only that physiography may be approached from a purely dynamic view-point but also that that view-point enjoys a measure and type of independence not shared by the other.

Geomorphology—the Passive Phase

Geomorphology is concerned with the details of surface configuration expressed first by the origin of that form and second by the influence of lithology and rock structure. The method of origin has interest only because it explains and rationalizes important lineaments in the composition of the landscape. The form strangely enough is actually a transient, unstable affair connecting in its descriptive aspects with ecology and geography. The study of land form has thrived during the last forty years since the elucidation of the geographic cycle which, without doubt, stands out as the quintessence of geomorphological description.

Primary and secondary physiographic features may be recognized as two fundamental types. The primary features originate in processes chiefly destructive and include such forms as valleys, ridges and mesas, whereas the secondary features result from activities chiefly constructive and refer to such forms as fans, deltas and flood plains.

Relations

Geodynamics bears the same relation to geomorphology that cause does to effect. Perhaps it is the apparently abstract nature of processes which has caused the dynamical view-point to be slighted. The wind, the river and the undertow are more difficult to study than the sand dune, the valley and the beach. Streams after all constitute the life of a fluvial situation. They are in fact similar to life—cyclic and eternal ever since the time when they began. They are the immortal soul; sediments and disconformity, simply the "fossil" indications of their presence in the distant past.

The most interesting phase of geomorphology in many ways lies in the study of surface expression as influenced by lithology and rock structure. A full appreciation of surface detail can not be obtained, however, without a knowledge of the process involved, for, without the vitalizing fingers of that process at least mentally visible, the form lies cold and dead. The active forces shape the hills and valleys that blend and flow like clay in the hands of the artist.

A clearer idea of the relative importance, position and relationship of the active phase of physiography may be had if we introduce the idea of the dynamic interlude. Geologically, it includes the series of events changing original rock into resultant sediments; physiographically, it refers to those processes which carve the primary features out of the original, or initial, land form and finally produce the so-called secondary features. A skeletal outline will serve to illustrate the physiographic relations. The outline, not all-inclusive of course, actually represents an expanded form of the familiar erosion-deposition formula.

→ Primary form

Original form—Weathering—Rainwash—Pick-up—Transportation—

→ Secondary form

→ Primary form

—Corrasion—Deposition—Secondary form

Summary

Physiography may be viewed from two distinct angles, the one dynamic, the other passive. The processes hold the fascination inherent in energy and force; the products exhibit all the beauty and diversity of form in the composition of landscapes. The tacit adoption of a particular view-point not only will avoid confusion but will also simplify to a great extent both oral and written presentation of physiographic subjects, especially to beginners. We ought, perhaps, to discriminate clearly between process and product.

In a restricted fashion geodynamics studies the process, force or activity, simply acknowledging the form as a passive result. Geomorphology considers the form to be a detailed expression of the influence of rock and structure and acknowledges the process

as a cause chiefly in relation to the gross lineaments of the ensemble.

In a large fashion geodynamics is intimately associated with certain branches of geology, as sedimentation, while geomorphology connects physiography with geography. The dynamic interlude representing the active phase of physiography weaves the basic threads of geologic history.

OBITUARY

JESSE WALTER FEWKES

THE death of Jesse Walter Fewkes removes one who was an outstanding influence in the formative period of American archeology, particularly the archeology of our great Southwest. He was born at Newton, Massachusetts, on November 14, 1850, of parents whose ancestral lines in America extended back to the seventeenth century. In 1871 he entered Harvard and he graduated four years later with honors in natural history, besides being elected to membership in Phi Beta Kappa.

In 1874, while he was still an undergraduate, two papers on electrical subjects were published by him, but the year before he had come under the influence of Louis Agassiz in the latter's school at Penikese Island, Buzzards Bay, and this experience probably led him to turn his attention wholly to zoology. At any rate he took up graduate work in natural history and, after receiving the degrees of A.M. and Ph.D. in 1877, he continued zoological studies at Leipzig under Rudolph Lueckart between 1878 and 1880. Later he spent several months in Naples and at Villa Franca on the south coast of France as holder of the Harris fellowship. After his return to America he received an appointment as assistant in the Museum of Comparative Zoology at Harvard where, from 1881 to 1889, he had charge of the collections of the lower invertebrata. In 1881 he accompanied Alexander Agassiz to Key West and the Dry Tortugas for the study of marine life and two years later he visited the Bermudas on a similar quest. Every summer, from 1884 to 1887, he was assistant in charge of the younger Agassiz's marine laboratory at Newport, R. I., but in the spring of 1887 he pursued scientific studies at Santa Barbara, Santa Cruz and Monterey, California, as a guest of Augustus Hemenway, of Boston, and in the summer of 1888 he studied in Paris and engaged in field work in marine zoology at Professor Lacaze Duthier's zoological station at Roscoff, Brittany.

Dr. Fewkes's visit to California proved to be a turning-point in his career, for it was then that he came in contact with the culture of the Pueblo Indians, which excited in him an interest still further stimulated by the enthusiasm of Mrs. Mary Hemenway. In 1889 and 1890 he undertook field work among the Zuñi Indians of New Mexico, and in the latter year he made use of a phonograph—the first time, it is believed, that it was so employed—in the recording of Indian music. In 1891 he became director of the Hemenway Southwestern Archeological Expedition and editor of the *Journal of American Archeology and Ethnology*, established to publish the results of its investigations. During the same year he began those studies of Hopi ceremonials for which he became especially noted and which probably constitute his most enduring contribution to American anthropology. His description of the Hopi Snake Dance, which appeared in 1894, was a pronounced factor in spreading the knowledge of this striking rite and stimulating popular interest in it.

The Hemenway expedition having been invited by the Spanish government to participate in the Historical Exposition held at Madrid in 1892–93 to commemorate the discovery of America by Columbus, Dr. Fewkes was given charge of the exhibit and he was a member of the jury of awards. In recognition of these services he was honored by Maria Cristina, queen regent of Spain, with the decoration "Isabel la Católica," grade of knight. In 1894 King Oscar of Sweden presented him with a gold medal, "Litteris et Artibus," for his work in anthropology.

After returning to America Dr. Fewkes resumed investigations in the Southwest, but they were soon brought to an end by the death of his patroness, Mrs. Hemenway, in 1894. The collections made under his direction during this period are in the Peabody Museum at Cambridge.

In May, 1895, Dr. Fewkes received an appointment as ethnologist in the Bureau of American Ethnology at Washington along with the honorary title of collaborator in the division of ethnology in the United States National Museum, and the connection which he established with the bureau at this time continued unbroken until his resignation and retirement from active service in 1928.

This constituted a turning-point in his career in another direction because, although he continued to publish the results of his work among the living Hopi for many years afterward, his field excursions now became mainly archeological. From 1895 until 1901 the scene of these investigations was in and near the Hopi country in Arizona, but in 1902–04 he made a diversion to the West Indies in continuance of an interest

which he had exhibited as far back as 1891, and he devoted the field season of 1905 to northeastern Mexico.

With the passage of the Lacey Act in 1906 providing for the creation of public parks or "national monuments" a new era dawned in the history of Southwestern archeology, and the services of Dr. Fewkes were at once enlisted by the Department of the Interior for the exploration and restoration of ruins upon the public domain. In 1906 and 1907 he explored and repaired the famous Casa Grande ruins of southern Arizona, but in 1908 transferred his labors to the Mesa Verde National Park in southwestern Colorado and continued there through the field season of 1909.

In 1911, he returned to the West Indies, visiting Cuba, the Isle of Pines and Grand Cayman, and, in 1912, the Lesser Antilles, but the following spring he went to Europe where he spent part of his time studying the West Indian collections in German and Danish museums. In 1915 and 1916 he resumed work at the Mesa Verde.

On March 1, 1918, Dr. Fewkes was appointed chief of the bureau of which he had so long been an active member. However, this appointment scarcely interrupted the course of his field investigations, which continued until 1923 in the region of the Mesa Verde. The principal ruins excavated and repaired by him in that park during his entire period of service there were Spruce Tree House, Cliff Palace, Square Tower House, Painted House, Cedar Tree House, Pipe Shrine House and Far View Tower, while the Hovenweep and Wupatki National Monuments were created in 1923 and 1925, respectively, as the result of his suggestions. His last outdoor work of importance was the excavation of Elden Pueblo, near Flagstaff, Arizona, in 1926.

As chief of the Bureau of Ethnology Dr. Fewkes also found time to interest himself in the archeology of the southeastern part of our country which he visited several times. His most important undertaking here was the excavation of the Weeden Island mound, near St. Petersburg, Florida, in the winter of 1923–24, and it is characteristic of his archeological optimism that his very last expedition consisted in a "reconnaissance" of the Piedmont region of South Carolina in June, 1927, looking toward more extensive investigations at some later period.

In April, 1925, Dr. Fewkes had to undergo a severe operation and, while he returned to the field, as noted, in 1926 and 1927, he never recovered fully from its effects. After his return from the South in 1927 he suffered a fall and, as a result of it, became so much weak that on January 15, 1928, he resigned as chief but continued on the staff of the bureau until November. His death took place on May 31, 1930, his wife, who had been his constant field companion, preceding him by a few weeks.

Dr. Fewkes was a member of the National Academy of Sciences and an honorary or corresponding member of many scientific societies, American and foreign. He was secretary of the Boston Society of Natural History from 1889 to 1891, vice-president and chairman of Section H of the American Association for the Advancement of Science in 1901 and again in 1915, president of the Anthropological Society of Washington in 1909 and 1910, president of the American Anthropological Association in 1911 and 1912, and for more than thirty years he was on the visiting committee of the Peabody Museum of Harvard University.

In January, 1915, he was the official representative of the Smithsonian Institution at the inauguration of Dr. KleinSmid as president of the University of Arizona and had bestowed upon him by that institution the degree of LL.D. On the occasion of his seventieth birthday, November 14, 1920, a luncheon was given in his honor at the Smithsonian building, participated in by about forty of his friends, and a specially bound volume of letters of congratulation was presented to him. His last public act was the presentation of a bust of Louis Agassiz to the Hall of Fame on behalf of the American Association for the Advancement of Science and an unnamed admirer of the great naturalist. This took place on May 10, 1928, Dr. Fewkes being the only pupil of Agassiz then living able to be present.

His publications include, besides the two papers on electricity already mentioned, nearly seventy contributions to invertebrate zoology, mainly the Medusae, Echinodermata and Vermes, and about two hundred contributions to ethnology and archeology.

Dr. Fewkes was possessed of a genial and confiding nature and an effervescent enthusiasm which drew people to him and made them readily communicative of any information they happened to have regarding new types of ruins, unique pottery or mounds which had escaped scientific eyes, so that, from the quantity point of view, he was almost uniformly successful in his field expeditions. And in this way he made many openings for later workers, even though he did not exploit all the possibilities of an undertaking. For he was interested in variety of material, especially material of a novel character, rather than in associations of material, and the extension of his work interfered with its intensiveness. However, his unaffected pleasure in a new variety of artifact or an exceptional pottery design was something that the average man could understand and through his talks to tourists and in the lecture hall, and through press interviews,

he interested hundreds to whom a more rigorous student might have spoken in vain. In this way he created a "Pueblo consciousness" which drew other investigators to the field and provided popular support for their work, performing a similar service to that of Cushing at an earlier date on the side of ethnology. Thus the title "dean of American archeology" which, with advancing years, some of his admirers came to apply to him was not inappropriate. It was a term which his charm of manner set off to most excellent advantage, and he had a devoted circle of friends who will feel that his going has removed something peculiarly warm and winning from their lives.

JOHN R. SWANTON

RECENT DEATHS

COLONEL WILLIAM BOYCE THOMPSON, mining engineer and copper operator, who founded the Boyce Thompson Institute for Plant Research with an endowment approaching ten million dollars and who gave other large sums for public purposes, died on June 28 at the age of sixty-one years.

PROFESSOR CHRISTEN LUNDSGAARD, professor of internal medicine at the Royal University of Denmark at Copenhagen, formerly an associate of the Rockefeller Institute for Medical Research and a member of the American Society for Experimental Biology and Medicine, died on June 16. He was forty-seven years old.

Nature reports the death of Mr. Arthur Stanley Hirst at sea on May 4. Mr. Hirst was formerly an assistant keeper in the British Museum (Natural History). He was born in 1883.

DR. J. B. BRADBURY, for the past thirty-six years professor of medicine in the University of Cambridge, died on June 4 at the age of eighty-nine years.

THE death is announced of Dr. Kiyoo Nakamura, director of the Central Meteorological Observatory of Japan.

MEMORIALS

Industrial and Engineering Chemistry reports that the Northeastern Section of the American Chemical Society, through a committee composed of Lyman C. Newell, Arthur D. Little and James F. Norris, has announced the establishment of a gold medal to commemorate the many fundamental contributions made to chemistry by Theodore William Richards. The medal will be awarded by the Northeastern Section at intervals of two or three years for conspicuous achievements in chemistry, and is being designed by Cyrus E. Dallin, a sculptor who was an intimate friend of Professor Richards. An opportunity is offered the friends of Professor Richards to assist in securing the sum of ten thousand dollars which is required to cover the initial expenses and provide a trust fund yielding sufficient income for the successive medals and incidental expenses.

DEDICATION ceremonies for Atwater Laboratory, the new building to house the animal disease and the genetics departments of the Storrs Agricultural Experiment Station, Connecticut, were held on June 12. The laboratory of brick and brown stone, two stories and a basement, was erected at a cost of $42,000. It was named for Wilbur O. Atwater, professor of chemistry at Wesleyan University, first director of the Storrs Station and of the United States Office of Experiment Stations. On the program of the dedication were Dr. Edward C. Schneider, professor of physiology at Wesleyan; Dr. Edward H. Jenkins, director emeritus of the experiment station, and Dr. A. F. Blakeslee, vice-director of the Carnegie Station for Experimental Evolution in Cold Spring Harbor, L. I., formerly professor of botany at the Connecticut Agricultural College, Storrs. Dr. George Alan Works, president of the college, presided. Guests from many colleges and research institutions attended the ceremonies and the luncheon that followed.

IN commemoration of the twenty-fifth anniversary of the discovery of the spirochete that is the causative agent of syphilis, memorial exercises in honor of the discoverer, Dr. Fritz Schaudinn, were held, May 17, in the Zoological Institute, Berlin. At the same time, his workshop or laboratory was dedicated as the "Schaudinn Room." Professor Max Hartmann and Professor Hesse delivered the memorial addresses.

SCIENTIFIC EVENTS

NATIONAL HYDRAULIC LABORATORY

ON May 14 last, the following bill was signed by President Hoover:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby authorized to be established in the Bureau of Standards of the Department of Commerce a national hydraulic laboratory for the determination of fundamental data useful in hydraulic research and engineering, including laboratory research relating to the behavior and control of river and harbor waters, the study of hydraulic structures and water flow, and the development and testing of hydraulic instruments and accessories: Provided, That no test, study or other work on a problem or problems connected with a project the prosecution of which is under the jurisdiction of any department or independent agency of the government shall be undertaken in the laboratory herein authorized until a written request to do such work is submitted [illegible]

Director of the Bureau of Standards by the head of the department or independent agency charged with the execution of such project: And provided further, That any state or political subdivision thereof may obtain a test, study or other work on a problem connected with a project the prosecution of which is under the jurisdiction of such state or political subdivision thereof.

Sec. 2. There is hereby authorized to be appropriated out of any money in the Treasury not otherwise appropriated, not to exceed $350,000, to be expended by the Secretary of Commerce for the construction and installation upon the present site of the Bureau of Standards in the District of Columbia of a suitable hydraulic laboratory building and such equipment, utilities and appurtenances thereto as may be necessary.

A number of government departments have a long list of urgent problems awaiting solution, and the experiments in connection therewith will be taken up in the new laboratory as soon as it is completed. Among these are questions relating to large reclamation and water conservation projects in the West, the control of erosion below spillways and dams, losses of head in large pipe and channel bends, the flow of water over dams, the entrainment of air at tunnel and syphon entrances, the regulation of rivers, the laws of silting and erosion in drainage ditches and streams, and the improvement of instruments and devices for measuring flowing water.

Owing to the great variety of problems which will be submitted for study, the equipment of the new laboratory will be designed to furnish the greatest possible flexibility of arrangement and combination, so that it can be adapted easily to the simultaneous study of a number of different problems.

The fixed equipment will include electrically driven pumps for circulating the water, a large concrete water-supply basin, a concrete measuring tank, several steel weighing tanks, elevated control tanks for supplying water under several different fixed heads, a standpipe and piping systems for distributing this water to all parts of the laboratory and for returning it from the models under test to the supply basin. A large unobstructed floor will be provided where a number of models can be built and tested simultaneously.

WEATHER FORECASTS FOR AIRWAYS

THE Weather Bureau is organizing an expansion of its service in aid of aviation, which will provide frequent and regular weather reports covering approximately 13,000 miles of airways. Effective soon after July 1, these reports will provide sufficient detail to meet all needs.

On about 8,000 miles of these airways teletype lines will provide 24-hour communication with exchange of reports once each hour. The remaining 5,000 miles will be served by reports transmitted by telephone or telegraph and at such intervals as will best meet current needs. On nearly 3,000 miles of airways, over which there is as yet comparatively little flying (one or two daily flights each way), the bureau will provide a limited service.

The current reports along all of these airways are supplemented by specialized, short-period airways forecasts which are based primarily on the twice-daily, country-wide reports and weather maps used in the general forecasting service, and, secondarily, on a series of three-hourly reports concentrated at designated centers from a well-selected network of stations. Some of these reporting stations are on the airways and others are at a considerable distance from them. At present the centers to which these reports go and from which the short-period forecasts are issued are the airport stations at Cleveland, Ohio; Fort Crook, Nebraska; Salt Lake City, Utah, and Oakland, California. After July 1, the increased appropriation will enable the bureau to open three new offices, at Atlanta, Georgia, at Dallas, Texas, and at Portland, Oregon. About 110 reporting stations will transmit to these forecasting centers.

Bulletins and short-period forecasts based on these reports will be sent by teletype from the seven centers to other airports and to landing fields and will also be broadcast to aircraft in flight through a rapidly expanding network of radio stations maintained by the Department of Commerce.

The Weather Bureau's program provides for the establishment of observation from pilot balloons at several additional stations, including Albuquerque, New Mexico; Cincinnati, Ohio; Dallas and Del Rio, Texas; Elko, Nevada, and North Platte, Nebraska.

Outside of continental United States, the bureau is increasing its airways service in Alaska, where a new first order station is being organized at Nome. Pilot balloons will be stationed at Nome and Fairbanks. The service in the Hawaiian Islands will include a chain of inter-island stations from which reports will be transmitted by radio to Honolulu, there to be made available for the information of pilots flying from one island to another.

The Weather Bureau also announces that it is continuing its investigations with kites, captive, pilot and sounding balloons and airplanes (through cooperation with the Navy Department), and is now engaged also in studies of ice formation on aircraft, turbulence or gustiness and other problems. The bureau's appropriation for all phases of its airways forecasting and study is $1,400,000.

APPOINTMENTS AT THE ROCKEFELLER INSTITUTE

THE Board of Scientific Directors of The Rockefeller Institute for Medical Research announces the

following appointments and promotions on the scientific staff.

New Appointments: Assistants—J. Lionel Alloway, Albert J. Anthony, James V. Bickford, Laurie L. Burgess, Frank Cortese, Macdonald Dick, Robert C. Elderfield, Filip C. Forsbeck, Kenneth Goodner, Benjamin E. Hodge, Stephen S. Hudack, Lewis G. Longsworth, Margaret J. Pittman, Paul D. Rosahn, William B. Rose, Kenneth C. Smithburn, Douglas H. Sprunt, Radford C. Tanzer, Robert Thomas, Robert S. Tipson and G. Payling Wright. Fellow—Basile J. Luyet.

Promotions: Associate Member to Member—Peter K. Olitsky. Assistant to Associate—Mortimer L. Anson, Robert B. Corey, René J. Dubos, Rebecca C. Lancefield, Currier McEwen, Alfred E. Mirsky, Albert L. Raymond, Julius Sendroy, Jr., Richard E. Shope. Fellow to Assistant—Fred Smith.

Resignations: Charles A. Doan to become professor and chairman of the department of medical and surgical research of Ohio State University; Robert R. Hannon, associate professor of medicine, Peiping Union Medical College; James A. Hawkins, associate professor of applied biochemistry, department of ophthalmology, Washington University Medical School, St. Louis; Louis A. Julianelle, associate professor of applied bacteriology and immunology, Washington University Medical School; William S. Tillett, associate professor of medicine in charge of the department of biology, Johns Hopkins Medical School.

THE DEPARTMENT OF PHYSICS OF HARVARD UNIVERSITY

As reported in the *Harvard Alumni Bulletin*, members of the staff of the Harvard department of physics will spend the summer vacation in writing, travel and research as follows:

Professor P. W. Bridgman will be engaged in writing at his summer home in Randolph, New Hampshire. Preparation for his research on the properties of matter under high pressure at the Jefferson Physical Laboratory will be carried on during his absence by an assistant.

Professor William Duane will supervise his general X-ray research in connection with the work of the Harvard Cancer Commission, both at the Harvard physical laboratories and the bio-physical laboratories at the Huntington Hospital. He will also supervise the installation of a radium plant at the Palmer Memorial Hospital.

Professor F. A. Saunders, of the Jefferson Laboratory, will revise his "Laboratory Manual on General Physics" and will be occupied with the plans for the new physics laboratory.

Professor E. L. Chaffee, of the Cruft Laboratory, will spend the vacation at his summer home in Ludlow, Vermont, where he will complete the first volume of his textbook on radio vacuum tubes.

Professor N. H. Black, of the Jefferson Physical Laboratory, will be on sabbatical leave during the academic year 1930–31. He will study the methods of teaching science at the English public schools—Eton, Harrow, etc. —and later will engage in research at the Cavendish Laboratory, University of Cambridge.

Professor E. C. Kemble, of the Jefferson Laboratory, will give courses on quantum mechanics and molecular spectra at the summer session at Cornell University.

Professor J. C. Slater, of the Jefferson Laboratory, will be engaged in writing a volume on the quantum theory of the structure of atoms, molecules and solids at his summer home near Rochester, New York.

Professor R. F. Field has resigned from the staff of the Cruft Laboratory and accepted a position as research engineer at the General Radio Company, Cambridge, Massachusetts.

F. H. Crawford, instructor in physics, will spend the first half of the summer vacation in research on band spectra at the Jefferson Laboratory.

Of the instructors in physics at the Cruft Laboratory, H. R. Mimno will continue his research on radio frequency amplifiers, F. V. Hunt will be engaged in the calibration of acoustic measuring devices, R. W. Hickman will continue his work on gas-filled vacuum tubes and W. N. Tuttle will travel in England, Holland and Germany, visiting the great physical laboratories of those countries.

HONORARY DEGREES FROM THE UNIVERSITY OF NEW HAMPSHIRE

THOMAS A. WATSON, Boston; Wilton E. Britton, New Haven, and Ambrose Swasey, Cleveland, were among those receiving honorary degrees from the University of New Hampshire. The citations given were as follows:

WILTON EVERETT BRITTON—Entomologist of the Connecticut Experiment Station; Connecticut State Entomologist; graduate of this institution in the Class of 1893; horticulturist in Connecticut for six years; teacher in the Yale Forestry School; doctor of philosophy from Yale University. Your steady progress in the great science to which you have given your life—the science that protects the crops of the farmer and makes safe the food supply of the nation—has been rewarded during the years by many and marked honors. You have been the president of the American Association of Economic Entomologists and for twenty years the associate editor of the *Journal*. You have served one state for almost four decades, but your influence has gone far beyond its borders. Your devoted labors have won for you international reputation in your profession, a reputation of which your Alma Mater is justly proud.

THOMAS AUGUSTUS WATSON—On the last page of a delightful life story you have written these words—"mountains have always reminded me of my telephone days, probably because my first sight of them was so impressive on the notable day I spent in North Conway,

New Hampshire, in December, 1876, when I talked with Alexander Graham Bell in Boston over the first long line over which we tried the telephone." You were the first to hear human speech "by telegraph"—from Cambridge and Conway to Boston, and from San Francisco and London to New York. You, moreover, made with your own hands the first telephone, and besides many other contributions you invented the bell that drives so many busy men, and even women, to the woods. You probably have the distinction of making the greatest single contribution to the jangling distraction of this noisiest of worlds. During twenty-five arduous years you founded and created one of America's great shipyards; you have been a pioneer of organized kindergartens; joint author of the geology of the Boston Basin; president of the Boston Browning Society; producer of Browning's dramas and interpreter of them even to the city of culture. Your accomplishments have been indeed varied and extraordinary. To-day New Hampshire claims you not because of the love of her mountains which crept into your soul in '76 to abide forever, not because your father was a native of near-by Newmarket, neither because in these latter years you find the center of New Hampshire the one place for rest and worship in the summer season, but because of the splendid breadth of your achievements both in science and art, and the hunger for beauty and truth which with the zest of youth still possesses and consumes you.

AMBROSE SWASEY—Native of beautiful Exeter and her constant friend and benefactor, manufacturer, captain of industry, inventor, scientist, philanthropist, founder of the Engineering Foundation, fellow of the Royal Astronomical Society, chevalier of the Legion of Honor and builder of the world's greatest telescopes including the Lick and the Yerkes. You have made it possible for mortals to peer into the near-by yet remote spaces of the illimitable universe, and to understand as never before the pregnant phrase, "What is man that thou art mindful of him and the son of man that thou visitest him?" You have combined the superlative practical achievements of creative business so delightfully with lofty idealism that those of us who know you are prompted to insist that institutions as well as individuals should hitch their wheels to ever nobler purposes. Recipient of honors too numerous to mention, you have been justly and fittingly decorated in many places and many lands. Your friends and neighbors view them all with sincere pride and joy. Yet, now, because you have been one of New Hampshire's most loyal, as well as one of her most distinguished sons, it seems fitting that we should here, to-day, place side by side with your other notable recognitions and rewards a simple wreath of home-grown bays.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the installation of Mr. Stanley Baldwin as chancellor of the University of Cambridge on June 5 the recipients of honorary degrees included Professor Albert Einstein and Professor Max Planck, of Berlin; Sir John Rose Bradford, president of the Royal College of Physicians, and Sir James Colquhoun Irvine, principal of the University of St. Andrews.

THE dedication ceremonies of the new medical building of the University of Brussels were held on June 24. The buildings were erected jointly by funds provided by the Rockefeller Institute and the city of Brussels. The degree of *doctor honoris causa* was conferred on Dr. Simon Flexner, director of the Rockefeller Institute, and on Dr. Abraham Flexner, formerly of the Rockefeller Foundation, who was recently elected president of the newly established Institute for Graduate Study at Newark, New Jersey.

IN recognition of his contributions to electrical science, Thomas A. Edison received a gold medal on June 20 at his laboratory in West Orange from a delegation representing the Argentine Association of Electro-Technicians. The presentation was made by William Asher Reece, president of the General Electric Company of the Argentine. Supreme Court Justice Owen J. Roberts presented on June 26 the John Scott Medal and an accompanying award of $1,000 to Mr. Edison at his laboratory, in recognition of "outstanding contributions to science."

THE Polytechnic Institute of Brooklyn held its seventy-fifth annual commencement on June 18, the speaker being Dr. Frank Pierrepont Graves, Commissioner of Education of the State of New York and alumnus of the institute. The honorary degree of doctor of engineering was bestowed upon President Karl T. Compton, of the Massachusetts Institute of Technology, and on Mr. Charles F. Kettering, president of the General Motors Research Corporation. The degree of Admiral Richard Byrd, who was delayed in returning to the United States, will be conferred upon him at a special convocation in the fall.

AT its seventy-fourth commencement Tufts College conferred the doctorate of science on Mr. Arthur D. Little, president of the Arthur D. Little Corporation.

CAPTAIN NICHOLAS HUNTER HECK, chief of the Division of Terrestrial Magnetism and Seismology of the U. S. Coast and Geodetic Survey, received from Lehigh University at its recent commencement the honorary degree of doctor of science.

DR. ZAY JEFFRIES, consulting metallurgist of Cleveland, delivered the address at the forty-third annual commencement of the South Dakota State School of

Mines on June 5. It was the twentieth anniversary of Dr. Jeffries' graduation from the institution which bestowed upon him the degree of doctor of engineering.

THE Pharmaceutical Society of Great Britain has placed on its distinguished roll of honorary members the names of the retiring dean, Dr. Henry H. Rusby, and Dr. Henry V. Arny, the dean-elect of the College of Pharmacy, Columbia University. These honors were awarded because of the scientific achievements of Dean Rusby and Dean-elect Arny and also to emphasize the cordial relations which have existed for a number of years between the School of the Pharmaceutical Society in London and the New York college.

THE current quarterly issue (June) of the *Annals* of the Association of American Geographers is entirely devoted to "An Appreciation of the Contributions to Earth Science of Albert Perry Brigham." In the words of the inscription, "This issue of the *Annals* is gratefully and admiringly dedicated to Albert Perry Brigham on his seventy-fifth birthday in recognition of his inestimable services to the Association of American Geographers and to the science of geography." Seven papers deal with Professor Brigham's career as follows: "Personal Sketch," by Professor R. E. Dodge, Agricultural College of Connecticut; "Geologist," by Dr. Philip S. Smith, U. S. Geological Survey; "Physiographer," by Dr. Kirk Bryan, U. S. Geological Survey; "Human Geographer," by Professor R. H. Whitbeck, University of Wisconsin; "Popularizer of Geography and Geology in the United States," by Colonel Lawrence Martin, Library of Congress; "Geographer-Envoy from America to Europe," by Professor Frank E. Williams, University of Pennsylvania, and "Educator," by Professor Robert M. Brown, Rhode Island College of Education. There is a recent portrait by Bachrach, and a full list of Dr. Brigham's books and papers.

DR. LAFAYETTE B. MENDEL, of Yale University, was elected to the staff of the Connecticut Agricultural Experiment Station, New Haven, at a recent meeting of the board of control. His title is research associate in biochemistry. Dr. Mendel collaborated with the late Dr. Thomas B. Osborne, who was in charge of the experiment station biochemistry department, in studies of nutrition that commanded worldwide recognition. Since Dr. Osborne's death, the work has been carried on with Dr. H. B. Vickery, who is now head of the laboratory of biochemistry. The action of the board of control is taken to recognize officially a relationship that has existed for years. Dr. Mendel is Sterling professor of physiological chemistry at Yale and chairman of the department of physiology and physiological chemistry.

DR. MARGARET C. FERGUSON, of Wellesley College, has been appointed research professor in botany and given the aid of a full time assistant. This was made possible through the generosity of Miss Susan Minns, of Boston.

DR. F. J. SIEVERS, director of the Massachusetts Agricultural Experiment Station, was recently elected to serve also as director of the graduate school at the Massachusetts Agricultural College following the resignation of Dr. H. T. Fernald.

AT Cornell University Professor Madison Bentley has been granted a year's leave to occupy the chairmanship of the division of anthropology and psychology in the National Research Council. Professor K. M. Dallenbach, who is lecturing this summer at the University of Oregon, will also be on leave during next year. He will be visiting professor of psychology at Columbia University and his place at Cornell will be temporarily filled by Professor John G. Jenkins, of the Iowa State College at Ames. Mr. Robert Brodie MacLeod has been appointed instructor at Cornell to take the place of Dr. George Kreezer who goes to Germany as a national research fellow in the biological sciences.

PROFESSOR H. R. ROBINSON, professor of physics at University College, Cardiff, has been appointed professor of physics at the East London College of the University of London to succeed Professor C. H. Lees who will retire.

THE new portfolio of fisheries in the Canadian Cabinet will be filled by Dr. Cyrus MacMillan, of McGill University, a representative of Prince Edward Island.

DR. O. E. HARDER, in charge of the department of metallography in the University of Minnesota, has been appointed an assistant director of the Battelle Memorial Institute. Dr. Harder will devote part of his time to the work being conducted at the institute by the alloys of iron committee of the Engineering Foundation.

MR. ROBERT J. MOORE, for the past six years general research chemist of Pratt and Lambert, Inc., Buffalo, N. Y., has resigned to become development manager of the Varnish Resin Department of the Bakelite Corporation. Mr. Moore will work under Dr. L. V. Redman, vice-president in charge of research and development, at the Bloomfield Division, New Jersey. He will be concerned with the application of the newly developed Bakelite resins in airdrying varnishes, enamels and lacquers.

MR. RALPH T. K. CORNWELL, senior microanalyst of the National Institute of Health (Hygienic Lab-

oratory), U. S. Public Health Service, Washington, D. C., has resigned to accept a position with the Sylvania Industrial Corporation of Fredericksburg, Virginia.

DR. WARD B. WHITE, for the last eight years director of the bureau of chemistry, New York State Department of Agriculture and Markets, has accepted an appointment as chief of food control, Food, Drug and Insecticide Administration, to fill the vacancy caused by the death of R. W. Balcom.

MR. S. J. COOK, chief of the Mining, Metallurgical and Chemical Branch, Dominion Bureau of Statistics, Ottawa, has been elected general secretary of the Fifth Pacific Science Congress, which for the first time will visit Canada in 1932.

DR. WALTER F. WILLCOX, of Cornell University, will represent the United States at the International Institute of Statistics which meets in Tokyo in September.

DR. PAUL BARTSCH and assistants have left Washington for a four months' cruise and exploration of the Bahamas and islands lying southward. A 70-foot vessel with an oil-burning engine was chartered at Miami, Florida, from which place they sailed on June 9. The expedition is made possible by the granting of the Walter Rathbone Bacon Traveling Scholarship.

DR. H. E. GREGORY, of Yale University and head curator of the Bernice P. Bishop Museum, Honolulu, visited Washington recently to inspect exhibits of Polynesian objects at the U. S. National Museum, principally from Samoa, the Hawaiian Islands, New Zealand, and the Hervey, Cook and Easter Islands with the object of negotiating an exchange of duplicate material between the National and the Bishop Museums.

DR. MAURICE L. TAINTER, associate professor of pharmacology in the Stanford University School of Medicine, left on June 19 for six months' study and travel abroad.

DR. MCKEEN CATTELL, assistant professor of physiology in the Cornell Medical College, New York City, sailed on June 28 for England, where for eight months he will be engaged in physiological research.

THE sixth International Congress of Genetics will be held at Ithaca, New York, from August 24 to 31, 1932, under the presidency of Dr. Thomas Hunt Morgan.

AT the meeting of the Seventh International Ornithological Congress at Amsterdam, Professor Lönnberg, of Sweden, was president, and Professor L. F. De Beaufort, secretary. The membership was larger than at any previous congress, being over 300. In addition to lectures by experts in different branches of the science, excursions were arranged to protected areas to see the rich bird life of Holland. At the final meeting on June 7 it was announced that the congress would in future be held every four years, instead of every five years; that the next meeting would take place in London in 1934, and that the president would be Dr. E. Stresemann, of Berlin, and the Rev. F. C. R. Jourdain, of Southbourne, Bournemouth, would be secretary.

THE third Imperial Entomological Conference opened on June 17. The meetings of the conference were, by courtesy of the Entomological Society of London, held in the society's new council room and were attended by delegates from the governments of twenty-four dominion, colonial, etc., governments, in addition to representatives of the Imperial College of Tropical Agriculture, Trinidad; the East African Agricultural Research Station, Amani, and government departments in the United Kingdom. At the opening meeting, which was confined to delegates, the conference discussed the work and finances of the Imperial Bureau of Entomology. Visits were arranged to the Parasite Laboratory of the Bureau at Farnham Royal, to Cambridge and to the Rothamsted Experimental Station and the Pathological Laboratory of the Ministry of Agriculture at Harpenden. The subjects of the various sessions were as follows: the organization of entomological departments, entomological work among backward races, tsetse-fly control, the control of insects by cultural methods, locusts, the biological control of insects, the control of weeds by insects and the control of orchard pests.

FOUR o'clock Saturday afternoon public lectures will be given during July and August in the lecture hall of the New York Botanical Garden. The subjects and lecturers are as follows: July 5. "The Philippine Islands," Dr. Elmer D. Merrill, director-in-chief; July 12. "Porto Rico: Its Flora and Scenery," Dr. Marshall A. Howe, assistant director; July 19. "Plant Traps," Dr. John Hendley Barnhart, bibliographer; July 26. "Diseases and Pests of Ornamentals," Dr. B. O. Dodge, plant pathologist; August 2. "Fungi, Edible, Poisonous and Otherwise Interesting," Dr. Fred J. Seaver, curator; August 9. "Florida," Dr. John K. Small, head curator of the museums; August 16. "Fossil Plants of New York City and Vicinity," Dr. Arthur Hollick, paleobotanist; August 23. "Wild Flowers of Late Summer," Dr. Forman T. McLean, Supervisor of Public Education, and August 30. "Growing Plants in Artificial Climate," Dr. J. M. Arthur, Boyce Thompson Institute.

DISCUSSION

ON THE ALLEGED EFFECT OF POLARIZED LIGHT ON FILMS OF STARCH

IN SCIENCE[1] there was published last summer a note describing the observations concerning the action of polarized light reported by Miss Semmens at the Cape Town meeting of the British Association for the Advancement of Science. This note pointed to the very striking result that a beam of moonlight—known to be polarized—was able to hydrolyze (to simple sugars apparently) boiled starch carried in films on filter-paper. Her demonstration was based on the fact that objects able to cast shadows on the disks of paper left traces revealed on developing with an iodine solution. The shadows or zones not exposed to radiation were said to appear slightly deeper in color than the exposed parts.

At that moment the *Scientific Transactions* of the British Association[2] was not available to give more information as to her procedure, but from the note referred to we tried to repeat these experiments both with moonlight and with artificial illumination. Since then we have had access to the original abstract of the communication, but unfortunately it is scarcely more explanatory. It was attempted to have our technique as close to hers as could be guessed from the abstract.

Disks of filter-paper (four different makes represented by nine different types of paper as to size of grain), were treated with different solutions of starch (corn, potato and soluble starch) at concentrations ranging from 0.5 per cent. to 5 per cent. The filter-paper was thoroughly washed with distilled water (cold or boiling). These disks were used under three conditions: thoroughly wet, damp and air-dried. Some were exposed on a glass plate, the shadow-casting objects being made of brass, steel, bakelite and blocks of glass covered with black paper. Care was taken to mark with suitable points the corners of the blocks. In a few cases, also, the whole procedure was carried out in a Petri dish. We irradiated the objects perpendicularly to the plane of the paper, taking the trouble to reorient the carrier of the disks every fifteen to thirty minutes when moonlight was used. We checked also the fact that the moonlight was polarized. The artificial light used was a thousand watt bulb whose rays were passed through a large Nicol prism; heat filters were placed between lamp and prism; the spectrum of the light extended from 420 mμ to 700 mμ. Some controls in the dark and in ordinary light of the same intensity as the polarized light were run at the same time. The intensity of illumination varied from 57 m. c. to 550 m. c.; the duration of irradiation ranged from fifteen minutes to six hours. The development of the disks was done with different concentrations of Lugol's solution diluted so as to give a color ranging from barely visible to deep blue-black coloration.

Our results were striking in their consistency: in no circumstances could the author or persons called to judge the differences in colors (and all these were familiar with the iodine starch reaction) detect any difference that could be related to the supposed phenomenon.

If Miss Semmens's contention is correct, there must have been present in her procedure some as yet unrecorded feature. It is at least apparent, however, that the alleged effect can not be of general occurrence.

A. E. NAVEZ

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[1] SCIENCE, 70: xiv, August 30, 1929.

[2] See *Scient. Transact.*, Brit. Assoc. Adv. Sci., Meeting South Africa, p. 12 and 70, 1929.

INCREASED ACCURACY IN THE DETERMINATION OF CARBONATES IN SOIL

IT has been known for a long time that in the determination of carbonate in soils carbon dioxide is frequently obtained from some soil constituent other than carbonate minerals, and that the amount so obtained is likely to be greater if the soil is unusually rich in organic matter and comparatively strong hydrochloric acid at a high temperature is employed for decomposing carbonates. With many soils the error from this cause is by no means negligible when 1:10 hydrochloric acid at room temperature or even 1:50 acid at 30° C. *in vacuo* is used. The source of carbon dioxide is commonly considered to be the soil organic matter, but no detailed explanation of the reaction involved has come to the writer's attention.

Considerable evidence has been secured indicating that this error is due to oxidation of organic matter to carbon dioxide, as the result of reaction with manganese dioxide native to the soil and the added acid. Not only is the amount of carbon dioxide obtained from sources other than carbonates increased by addition of powdered manganese dioxide to the soil prior to acid treatment, but also determinations of the active manganese dioxide in the soil by measurement of oxygen evolved from soil and 15 per cent. hydrogen peroxide indicate for similar soils a relation between this active manganese and the carbon dioxide obtained by acid treatment.

Addition of ferrous chloride to the acid reduces carbon dioxide from this source to a very small amount when 1:50 hydrochloric acid at about 30° C.

is employed for decomposing soil carbonates. With considerably stronger acid or at a higher temperature there is a slight error, but by the use of 1:10 acid with ferrous chloride at the temperature noted it is possible to recover very accurately all carbon dioxide from the most resistant dolomite mixed with soil. With some soils it has been noted that the results secured by use of the stronger acid are more accurate than those with a weaker reagent and longer time of action. It is evident that time of action as well as concentration of acid and temperature is a factor, and that oxidation is probably not the only reaction involved, although it may be the most important.

The decomposition of soil carbonates should therefore be effected at the lowest temperature and with the most dilute acid that can be used, consistent with recovery of all carbon dioxide from resistant carbonates in a short time. By the use of a special reagent to prevent oxidizing action the accuracy of the determination is greatly increased. It is planned to publish at an early date a detailed description of an apparatus and procedure for the determination of soil carbonates, including the above and other improvements in technique, whereby the determination can be conducted with the utmost certainty of correct results in a shorter time and with less trouble than is possible with any method previously described.

C. J. SCHOLLENBERGER
OHIO AGRICULTURAL EXPERIMENT STATION, WOOSTER

THE BEHAVIOR OF SUDAN III WHEN FED WITH CARBOHYDRATE

THE significance of the use of Sudan III in the study of fat metabolism is based on the observations of several investigators,[1] who have shown that this fat-soluble dye when mixed with a fat or oil is readily absorbed from the alimentary tract and is deposited in adipose tissue. The writer has found, in the course of some experiments on fat metabolism, that not only does a stained fat result in deposits of colored fat in the body, but cornstarch plus Sudan III will give the same results in white rats, six to eight weeks old or older, after four days of feeding only cornstarch and a large amount of dye. Similar results were obtained when the extraneous fat occurring in cornstarch was removed and this extracted cornstarch plus Sudan III was fed. Since it was thought possible that the fatty acids attached to a complex carbohydrate in corn α amylose might be responsible for the transport of the dye, other carbohydrates, such as sucrose, lactose and dextrin, were each fed separately with Sudan III. Each animal was allowed only distilled water from 5 P. M. one day until 8 A. M. the next day. The dye, one gram in eighty grams of the carbohydrate, was mixed with the dry material and fed without the addition of any other foodstuff. Five well-matched lots of five animals each were run on the following carbohydrates, cornstarch, rice-starch, dextrin, lactose and sucrose. In each case the dye was deposited especially in subcutaneous fat and the fat around the intestines and the testes. Exceptions were noted, however, in very young rats that became emaciated on this diet, and on autopsy, after four or five days, almost no fat was seen in the body.

Negative results occurred after feeding only two days, perhaps because the animals had not yet taken enough of the dye to show color. On the third day faint pink fat was noted in those animals autopsied, and on the fourth and fifth days unmistakable coloring of adipose tissue was found.

During the feeding of these animals results were noted that have been recorded by other writers, that the urine became pink in a day or two and that the feces were very dark red when first excreted and later became black and hard.

It has been claimed that Sudan III clings to the fat or fatty substance of the food with which it is fed and that it must be borne in mind that fat is necessary for the transport of the dye. In the present experiments, the question as to whether or not the dye fed with carbohydrate attaches itself to fat in its course through the body or whether fat is synthesized from the carbohydrate fed and deposited as colored fat can not be answered now.

EDITH H. MACARTHUR
DEPARTMENT OF NUTRITION,
COLLEGE OF HOME ECONOMICS,
CORNELL UNIVERSITY

[1] Gage and Gage, "Sudan III Deposited in the Egg and Transmitted to the Chick," SCIENCE, 28: 494, 1908; "The Coloration of Milk in Lactating Animals and the Staining of Growing Adipose Tissue in Suckling Young," *Anat. Rec.*, 3: 203, 1909; Mendel and Daniels, "The Behavior of Fat-soluble Dyes and Stained Fat in the Animal Organism," *Jour. Biol. Chem.*, 13: 71, 1912–13.

ANTHOCYANIN AS AN INDICATOR

IN connection with the article by O. B. Pratt and H. O. Swartout on "Fruit and Vegetable Pigments as Indicators" (SCIENCE, May 9, 1930, p. 486), I would like to call attention to an article by Professor W. J. Gies and myself, published in 1918 (*Proc. Soc. Exp. Biol. and Medicine*, 16, 8 (1918)) on plant pigments, in which the suggestion was then made that anthocyanin (obtained from the tulip, crimson king, etc.) could be used as an indicator. In fact, the properties of this anthocyanin were compared with phenolphthalein and it was shown that the range of the former varied from pH 5.3–9.2.

BENJAMIN HARROW

SCIENTIFIC BOOKS

The Epidemiology and Control of Malaria in Palestine. By ISRAEL J. KLIGLER, director, department of hygiene, Hebrew University, Jerusalem. The University of Chicago Press, 1930.

DR. ISRAEL J. KLIGLER, formerly of the American Museum of Natural History, later of the Rockefeller Institute and since 1921 working in Palestine, first as director of laboratories of the Hadassah Medical Unit, later with the Malaria Research Unit and since 1926 professor of hygiene in the Hebrew University, Jerusalem, has written an excellent book.

He thinks that the static condition of Palestine during the last several centuries is due almost entirely to malaria. While some antimalaria work was done in Egypt before the World War, nothing seems to have been done in Palestine until after the close of the great struggle. In 1921, however, Dr. Kligler took up such a study under the auspices of the Hadassah Medical Organization, then the American Zionist Medical Unit. The present book gives the results of the work since that time. Dr. Kligler is a broad medical investigator, but he is not a trained entomologist. Fortunately, in 1923 Dr. P. A. Buxton held the position of medical entomologist to the British government of Palestine and submitted a report published in the *Bulletin of Entomological Research* for March, 1924, the bulk of which was devoted to entomological matters of medical or veterinary interest. I imagine that the mosquito material collected by Dr. Buxton must have passed through the hands of the entirely competent culicidologist, F. W. Edwards, of the British Museum of Natural History. Therefore Dr. Kligler in his work is without doubt sound when he refers to the different species of Anopheles by name. He considers eight species of Anopheles, and his keys are based upon those of Buxton. The book is well planned and well illustrated, and the author shows a thorough familiarity with recently published work in different parts of the world. His chapters include: I. Topography and Climate; II. Social, Economic and Health Conditions; III. Actual and Potential Breeding Places of Anopheline Mosquitoes; IV. Bionomics of the Anopheles of Palestine; V. Incidence and Etiology of Malaria; VI. General Considerations of the Epidemiology; VII. Methods of Control; VIII. Results of Control Work; IX. Experiments with Various Control Measures in Districts where Antilarval Control was Unsuccessful. There is an appendix on typical drainage work of a permanent character. The book is therefore the result of a broad study, and all important facts have been considered carefully and at some length.

The methods of control are in the main those that have been used in other parts of the world, but there have been in Dr. Kligler's work some interesting variations. The brothers Sergent in Algeria were probably the first to suggest as a mechanical method the frequent changing of irrigating streams from one canal to another, bringing about the drying up of anopheline larvae. Dr. Kligler found it simple, with the breeding places caused by springs, to deflect the flow in a different direction from the natural course every five or six days, or, by damming the stream, storing the water behind the dam for two or more days and then releasing it, excellent results could be reached. Several variations of this general plan were tried with good effect. He insists, however, upon thorough drying, since he has found that the older larvae may remain alive for a considerable time in moist earth. Variations in the oiling method are described, and these experiments showed that the addition of 1 per cent. by volume of castor oil to a kerosene film is very advisable. Paris green was used in the proportion of one part to one hundred parts of fine sifted road dust or ashes.

The native cyprinodont fish are not effective as destroyers of larvae. They are not top-feeders. Imported Gambusias, however, were much more satisfactory, and they now occur in fairly large numbers in the open drainage canals and pools.

The volume contains much original and useful matter and should be very useful to antimalaria workers everywhere.

L. O. HOWARD

SCIENTIFIC APPARATUS AND LABORATORY METHODS

ELECTRODYNAMIC RECORDER

UNDER ordinary circumstances the kymograph upon which the responses of a stimulated muscle are recorded must be placed at no great distance from the muscle. With the device herein described, an attempt has been made to provide a means whereby kymograph records can be made at any convenient distance from the stimulated tissue.

The apparatus (Fig. 1.) is actuated like the direct, kymograph recording equipment now in use, *i.e.*, the muscle is hooked to a thread which, passing over a

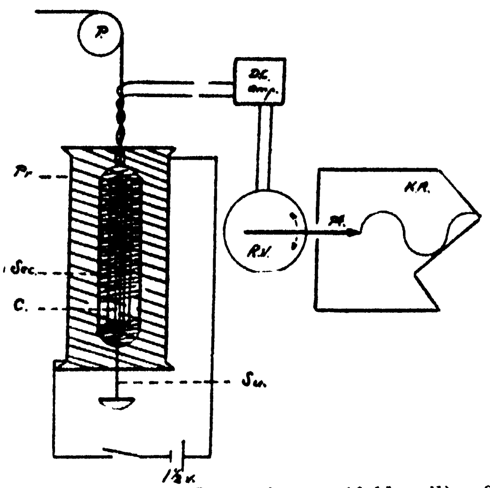

Fig. 1. *P.*, pulley; *Pr.*, primary (field coil); *Sec.*, secondary (moving coil); *C.*, soft iron core; *Su.*, weight support, or spring substitute; *D.C. amp.*, direct current amplifier; *R.V.*, recording voltmeter; *Pt.*, pointer; *K.R.*, kymograph record.

pulley, raises and lowers a specified weight or pulls against a spring of given substitute-weight. In this case, instead of the thread activating a pointer, a soft iron core around which is wound many turns of fine wire is raised and lowered in the magnetic field of a helix of heavy wire through which a small current passes. The core together with its secondary winding cuts the magnetic lines of force in the field, and a current is set up which operates a dead-beat, zero-center, recording voltmeter equipped with a light pointer and so adjusted as to record on a moving kymograph drum. A one or two-step D. C. amplifier in the secondary circuit provides a means of controlling the amplitude of the pointer-arc.

By varying the length of the wires between the movable iron core and the voltmeter it is possible to make records at any convenient distance from the research laboratory in which the activated muscle may be placed, *e.g.*, records may be made before a large class in the lecture room.

A detailed description of the electrodynamic recorder has been omitted because it is assumed that laboratory research means the fitting of fundamental apparatus to specific uses. (For certain uses, the recorder may be wired in such a manner that the movable core carries the energizing current, while the outer helix becomes a part of the secondary circuit.) It is felt, however, that the extreme sensitivity of the device, the simplicity of construction and the advantage of remote recording will recommend the apparatus to experimenters in physiology and psychology.

Lyman S. Judson
P. E. Griffith

University of Iowa

A SIMPLE AQUEOUS ELECTRODE

In threshold studies of sensitivity to high frequency E.M.F. stimulation the writer has devised a simple aqueous electrode which has proved very satisfactory in laboratory experimentation.

The complete electrode, schematized in Fig. 1, is a modified Mandler diatomaceous bacteriological candle

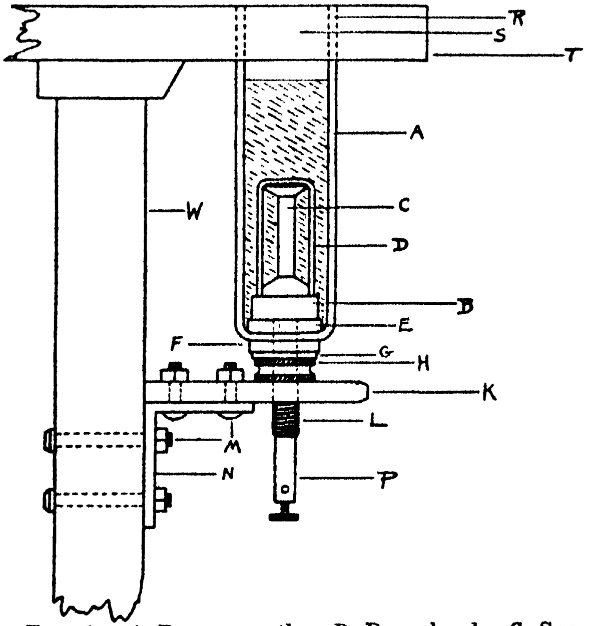

Fig. 1. *A.* Pyrex mantle. *B.* Base band. *C.* Supporting electrode. *D.* Inverted glass tube serving as finger rest. *E. F.* Soft rubber washers. *G.* Fiber washer. *H.* Brass lock-nut. *K.* Wooden base supported by right-angle iron. *L.* Threaded nipple. *M.N.* Fastening bolts. *P.* Binding post. *R.* Mantle protruding through writing ledge, *T.* *S.* Hole in writing ledge through which subject inserts finger. *W.* Fore leg of chair.

enclosed in a pyrex mantle. After the filter is removed, the base band, the concave drainage and the nipple are sealed, thus rendering the mantle liquid tight. By means of interposed cushion-rubber washers, the nipple lock-nut fastens the base band securely against the bottom of the pyrex mantle. A brass binding post is soldered to the lower end of the sealed nipple.

In place of the diatomaceous candle, a T-electrode is substituted which supports an inverted glass tube acting as finger rest. Filtered water is used as the liquid conductor. The electrode is not reliable when used in connection with psychogalvanic direct current circuits. It is quite effective, however, when used in connection with an inductorium as source. Since alternating current of relatively high frequency is employed as the stimulus, danger of polarization is eliminated.

The complete electrode is supported at the lock-nut

juncture by means of a right-angle iron attached to the anterior surface of the fore leg of a study chair. The top of the mantle conveniently passes through a circular hole in the writing ledge of the study chair. The writing ledge acts as an arm and finger rest for the subject. The mantle can be quickly removed from its supporting position and thoroughly cleaned without difficulty.

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SPECIAL ARTICLES

THE MYOGRAM OF THE ISOLATED SKELETAL MUSCLE CELL

THE determination of the contractile mechanism of a muscle cell from results procured in experiments upon an intact muscle presents the difficulty of differentiating between those factors attributable to the cellular process *per se* and those due either to a statistical distribution of the contractility of the fibers or to mechanical interference of the connective tissue enclosing the fibers. Moreover, the methods employed give no approach to the functional significance of the recognized structural elements within the muscle cell. The present investigation was undertaken, therefore, to develop a method of investigating the contractile and structural properties of single isolated muscle fibers. Opportunity is taken at this time to present a preliminary report of the results. A complete account will be published later.

METHODS

The method is to mount the single muscle fiber upon the tips of two glass needles, one needle being rigid, while the second, the micro-lever, is flexible so that its tip is free to move when the muscle contracts. The needles, mounted in a Chambers' micro-manipulator, are held in the field of a microscope. The image of the movable lever is projected upon the slit of a recording camera and adjusted at right angles to the slit by means of a suitable optical system.

For the glass micro-lever used it has been determined that the displacement of the tip of the lever is a linear function of the force applied.[1] The contraction curve of the muscle, therefore, can be converted into absolute units when necessary.

The micro-levers have a period of about 0.0016 seconds. This is a sufficiently short period for recording the contractions of these muscle fibers.

The muscle cell is stimulated by break induction shocks applied by silver-silver chloride micro-electrodes.

Preparations of the isolated cells of the sartorius muscle, 1 cm to 1.5 cm in length, are used. These are mounted in a hanging drop of frog serum in the customary moist chamber.

RESULTS

The results obtained can be described to the best advantage by reference to the records of the contractions in Fig. 1. These records show the following:

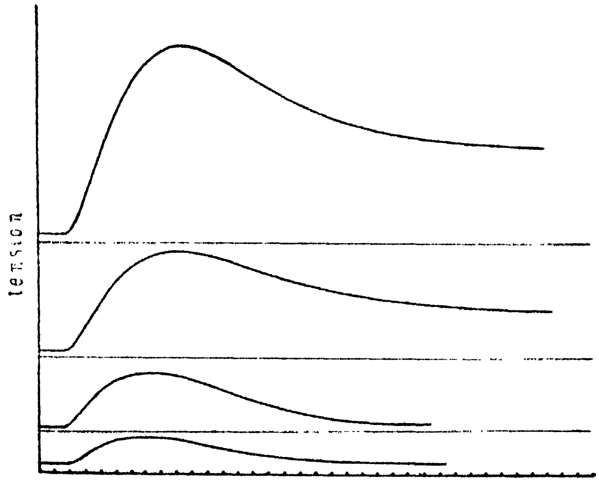

FIG. 1. Myograms from a single isolated fiber of the sartorius muscle showing a progressive increase in the magnitude of each response with increasing strength of stimulus. Temperature 23° ± 2° C. Time intervals represent 0.01 seconds.

(1) In the simple twitch of a skeletal muscle fiber the tension at the beginning of contraction rises abruptly, increases to a maximum, and then decreases to zero in a curve without discontinuities. No plateau or angle such as described by Fulton[2] for the intact muscle exists. These results are in agreement with those of Cooper and Eccles,[3] who ascribe Fulton's results to frictional interference in the muscle lever he used.

(2) An increase in the strength of stimulation results in an increase in the total tension developed and in the duration of the contraction. With strong stimuli the recovery from contraction is not complete, a new base line being reached.

[1] The method of calibrating the glass micro-levers will be published elsewhere by the junior author.

[2] J. F. Fulton, Williams and Wilkins Co., 1926.

[3] S. Cooper and J. C. Eccles, *J. Physiol.*, 69, 1930; *Proc. Physiol. Soc.*, III.

The variation in the magnitude of contraction with variation in the strength of stimulus indicates that the all-or-none law does not apply to the electrically stimulated muscle cell. Gelfan[4] has reached a similar conclusion for the fibers of the retrolingual membrane of the frog stimulated *in situ*. Before a definite conclusion can be reached in the present investigation it is necessary to determine whether the stimulating current is affecting only the excitable system involved in any type of stimulation no matter how produced, or whether there are also direct electrochemical effects of the current upon other components of the cell. Some evidence that such changes are involved has been obtained and the subject is now under investigation from the view-point of the relation between the chronaxie of the cell and the magnitude of the response. In any case a more rigid statement of the all-or-none law in terms of the excitable system of the cell than is customarily given is necessary.

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THE MYOCARDIUM IN YELLOW FEVER[1]

A PRELIMINARY REPORT

A SERIES of twenty rhesus and cynomolgus monkeys has been studied electrocardiographically before inoculation with yellow fever virus (Asibi strain) and at varying intervals during the course of infection with yellow fever. Of these animals only two recovered from the disease. The functional changes in the sino-auricular node, auricular muscle, auriculoventricular bundle and ventricular muscle recorded by electrocardiography have been compared with the histopathological changes in the corresponding cardiac tissues of each animal.

Bradycardia, regular in rhythm, absolute in degree and progressively more marked on succeeding days of the disease, has been a constant finding in experimental yellow fever in the monkey. The heart rate in these animals has been reduced in varying degrees ranging from 75 to 30 per cent. of the normal frequency. The bradycardia persisted independently of ether anesthesia and sodium iso-amyl-ethyl barbiturate anesthesia, and following bilateral section of the vagus nerves. This retardation of cardiac rhythm was associated with hyaline, granular, vacuolar and fatty degenerative lesions in the musculature of the sino-auricular node. In the animals which recovered from the disease the normal heart rate was gradually resumed.

Occasionally reduplication of the P wave of the electrocardiogram was observed in experimental yellow fever; more rarely this deflection was seen to be inverted. Well-marked degenerative changes have been found in the auricular muscle.

Prolongation of the conduction time of the auriculoventricular bundle, as measured by the P-R interval of the electrocardiogram, was observed in slight or moderate degree in 84 per cent. of cases. With few exceptions the delay in conduction was progressive, increasing from day to day of the disease. The P-R periods regained their normal values in the animals which recovered. This impairment of conduction was associated with the appearance of granular, fatty and vacuolar degeneration in the fibers of the auriculoventricular bundle.

Among electrocardiographic alterations in the ventricular muscle during the course of the disease, changes in ventricular preponderance were commonly observed. The R-T period was lengthened in 94 per cent. of cases, and frequently it was deformed. The T wave commonly took an early origin from the descending limb of the R wave or the ascending limb of the S wave with concurrent distortion of the R-T segment of the ventricular electrocardiogram. The normal upright T wave was replaced in 76 per cent. of the cases by a deflection either negative in direction or diphasic in contour, the latter change being represented either by two waves above the line of equipotential or by one positive and one negative wave in relation to the base line. In addition to these types of deformity of the terminal deflection, an upright T wave of increased height was frequently observed. These abnormal variations of the ventricular electrocardiogram appeared most frequently on the later days of the disease; but these disturbances were transient, fleeting in nature, present in one tracing and not in another, one type of variation being inscribed upon one occasion, a different deformity appearing during subsequent annotations. Their occurrence was associated with the presence in the ventricular muscle of these animals of hyaline, granular, vacuolar and fatty degenerative lesions.

A detailed account of which the above is a summary is in preparation and will be published in the near future.

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AND BACTERIOLOGY,
UNIVERSITY OF TORONTO

[4] S. Gelfan, *Amer. J. Physiol.*, 93: 1, 1930.

[1] This work was performed under the tenure of a grant from the Banting Research Foundation. The electrocardiographic studies were carried out in the Yellow Fever Laboratory of the Rockefeller Foundation and in the Physiological Laboratory of the Rockefeller Institute in New York, through the kindness of the directors of these laboratories, Dr. W. A. Sawyer and Dr. A. E. Cohn.

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THE CONTRIBUTIONS OF COUNT RUMFORD AND MICHAEL FARADAY TO THE MODERN MUSEUM OF SCIENCE[1]

By Sir WILLIAM BRAGG

DIRECTOR OF THE ROYAL INSTITUTION AND OF THE FARADAY RESEARCH LABORATORY

I AM told that I must say something about the "Diary of Michael Faraday," a book which we treasure at the Royal Institution. I would like to say a word or two about that at first but, as a matter of fact, I hope you will allow me to use it rather as a text for a somewhat larger subject, that is, the work that you and we are jointly trying to do.

Faraday's diary is indeed a most interesting document. It is contained in seven or eight large volumes of manuscript which have never been published. It is a record of his doings day by day. All his experimental work was collected by him from time to time and students in electricity know these papers and books of his quite well. But the diary is something more—it is the record day by day of what he thought, what work he was doing. It is a very human, very interesting document. He almost talks to us as he sits by night recording what happened to him during the day. Sometimes there is delight at having achieved success in an experiment, and sometimes a little fit of depression, as when he says, "So after all, that which I thought was a new discovery was only an accident." Sometimes he deliberately writes out an ordered plan for his next work. He uses some such phrases as: "So, if this takes place, the consequences should be. . . . Then I must try. . . ."

I assure you it is a most interesting book, and I trust the Royal Institution will succeed in publishing part of it next year. And then I hope that you all

[1] Address given by Sir William Henry Bragg at a science luncheon given in his honor at the Hotel Astor on May 27, 1930, by the Museums of the Peaceful Arts, the American Institute and the New York Electrical Society.

will feel the same charm that we do who have read it. The work that Faraday did is important to us in many ways because it is part of a great movement that is now beginning to take shape in the world.

If you would see the very beginnings of this movement, you will have to go back 250 years or more, to the time when such societies as the Royal Society of London first began to draw people's attention to the wonders of the world about them.

The first fellows of the Royal Society in London were just like a lot of school boys. As you look over the early volumes of the Royal Society *Transactions*, what will delight you most is the curious jumble of things submitted. Here is a man who gathers information respecting the ventilation of mines in Belgium. On the next page you will find a paper describing an animal monstrosity, etc. That was the Science Museum in those days.

If you step forward one hundred years or rather more, you come to Benjamin Thompson. Benjamin Thompson was a man who taught school in Rumford, Massachusetts—that was why he afterward assumed the particular title "Count Rumford." You will remember that in the time of the troubles between the colonies and the mother country, Rumford espoused the cause of the latter and was obliged to leave America.

Rumford was a strange man who believed in his heart in benevolent despotism. He went to England first and made his name both as statesman and as scientist. He afterwards went to Bavaria and took service with the Elector. He quickly rose to a position of considerable distinction and felt he was possessed of so much power that he carried out a most remarkable feat. He cleared the town of Munich of its beggars. Europe was overrun at that time, and in Munich they were estimated to be five per cent. of the whole population. He bought a building outside of the city, furnished it and on January 1, 1790 (which was Beggars' Day), Thompson so arranged with police officials of the city that, as each beggar put out his hand for alms, he was kindly but firmly led away to the Town Hall. There he was told that at the new institution there was food for him and warmth and liberty to work if he wanted it. It is hard to believe that such arbitrary measures could be successful, but the fact remains that he made the institution remunerative and its inmates happy, if we may believe his biographer.[2] That was indeed benevolent despotism.

He had the first ideas of applying scientific results to the needs of every-day life and he wrote several pamphlets on the subject. There are copies of them in this country. These pamphlets deal with what a scientific museum should be, how it should be conducted, what should be in it, what might be expected of it. He was a master of detail, and when you read over what he says, you realize you could not have a better guide if you wanted to set up a museum. He said, for example, that qualified instructors should be present to explain the models, and that is recognized now as one of the important features of a modern institution.

In a famous museum in Munich, where Rumford did his work, this principle is carried out in detail, and in the Science Museum of London there are hundreds of operating exhibits and the staff members are recognized generally as men of authority in their respective fields.

No doubt this is perfectly right. It is absolutely necessary to conduct a museum in this way. It is the best way to catch the public eye. I remember when I was a professor in Adelaide, we were to receive a visit from a member of Parliament. In connection with drawing his interest to our work, I remember the advice given me by a shrewd friend, "Mind you have something that buzzes or goes around." As a matter of fact, people do like to see things move.

Every year for more than a century Christmas lectures for children have been given at the Royal Institution. I notice that boys and girls like best to see demonstrations of mechanical principles, to see things working. We are all children still, and we do enjoy a science museum where there are working models and demonstrations of them. I think that the technique of a science museum is being gradually evolved. The operating model alone will not suffice, but I do regard it as one of the most fundamental means of instruction that we have.

I take it you represent these societies which are so interested in popularizing natural phenomena. We are linked together in one great endeavor to make the presentation of knowledge understood by the people and useful to them. That is the elemental feature.

Benjamin Thompson had great schemes. To those schemes, as a matter of fact, I owe my position, because it was under his scheme that the Royal Institution was organized in 1799. He was perhaps ahead of his time in creating an institution of working exhibits for public education. There is still a room that is called the model room. He called together various workmen—a plumber, a carpenter, a tinsmith, etc. He brought his various friends together to help in forwarding this idea. There was hardly sufficient understanding as to what might be done, or perhaps it was too ambitious, but at all events the scheme fell to pieces and he went back to Bavaria, but others remained behind, changed its purpose and went ahead.

Rumford always had the idea that there should be lectures, and certainly lectures are a very valuable ad-

[2] Rumford's life is described by Ellis in a book written at the instance of the American Academy of Arts and Sciences in Boston.

junct. Also the Franklin Institute, to which the Royal Institution is akin, has made great progress in this direction. To some extent these lectures have filled up the gap which Rumford saw but which are still to be perfected by institutions such as mine and yours. In our way we have tried to do it by having every week a discourse by some one who has really done something. He may have discovered something in chemistry or physics or built some bridge or discovered some historical remains, but the point is, he must have done something, and he lectures on that subject to people who are all interested in the progress in science and discovery.

I can not do better than to quote the directions given to the lecturer: He must speak on his subject to people who are interested in other subjects. He must not use technical terms which are not readily understood by all. It is a sort of liaison: an attempt to bind all the sciences together. The lectures have been a success and here I want to go back to Faraday.

This beginning by Rumford became an institution where research was carried on. But in those days systematic research was entirely new, and it was Davy and Faraday, who succeeded him, who were largely responsible for showing what research was and how it should be conducted. In that way the Royal Institution in London came to do scientific work that has played a great part in the world.

I won't attempt to describe what Faraday did because the subject is too great. What Faraday did is the foundation of all modern industry. He discovered the principle upon which the law of electrical engineering is built. He discovered the laws connecting electrochemistry and electricity, etc. I will give you a curious instance of how science develops into something at which everybody wonders.

One Friday evening a famous scientist was to give a lecture before the society and that afternoon Faraday spent with him going over the experiments, but when the evening came, the scientist had lost heart and never appeared. What could Faraday do? He went into the lecture room and went over the experiments as well as he could. When he had finished he began to pour out some of the thoughts that had been in his mind and when he had finished with this the subject had almost grown as he spoke. Afterwards he wrote a little paper, "Thoughts on Ray Vibrations," and this paper was, in fact, the starting-point of certain of his own researches into the electromagnetic theory and the foundation of the electromagnetic work of Maxwell and from that came the work of Hertz and from that came the achievements of Marconi and the modern wireless telephone.

Faraday's work was extremely fundamental and his work meant so much because he saw that experiment could draw together all the physical forms of the world. There is a certain passage in his works where he speaks of electricity, voltaic and static, gravity, heat, cohesion, magnetism, etc.—a whole list of different physical forces and of his hope of coupling them all together. In a way his life work might be looked upon as an attempt to link them all up, for he was convinced that they were connected, and I may prove and illustrate my point by citing the names you give certain fundamental discoveries.

Faraday was the first to discover the principle of electromagnetic induction. You talk now of the principles of electromagnetism. He saw the connection between magnetism and light. We talk of magneto-optics. He saw the connection between electricity and chemistry. We talk of electrochemistry. It was that unity in which he believed—the unity of all nature. He lifted science above that which Rumford and his previous workers had conceived.

As time grows and the horizon widens, we see that the first views of what science does are greater now. We are all committed to the attempt to try to bring it to the service of mankind. It is a great enterprise and we only see dimly now what can be done, but we do hope to do much. In the attempt to explore the wonders of the world, to add beauty where people did not see beauty before, we are doing something for the service of mankind.

Robert Bridges, in the last great work of his, has astonished us by its beauty and its greatness. If you read "The Testament of Beauty," you will find that he has expressed for us the beauty of science. He talks of the influence of dreadful war and he speaks of the time when science will have brought many together into peace through common understanding of the unity and beauty of the world. He speaks of the time when

War faln from a trumpeting vainglory to a crying shame
Stalks with blasting curse branded on its brow.

Now you see that what we are aiming at is such a development of science, such a development of the wonders of the world, that we may lose all animosities in thought and understanding. That we may see the knowledge of the world, and all that is in the world, is a great thing at which to aim. In science there is no religion, but it is the act of religion. If we are religious at all in the deepest sense, we must try to bring all the good we can into the world to the service of man, and that is the great work we are all permitted to do.

I feel very much honored that you allow me to come here to-day and speak on that service in which we all feel deeply.

SUGGESTIONS OF COUNT RUMFORD[3]

In the prospectus of the Royal Institution of Great Britain in 1800 occur in part the following statements of Count Rumford representing his ideas for the formation of a public institution for the diffusion of knowledge and for facilitating the introduction of useful mechanical inventions and for bettering the condition of the poor:

> The completest working models or constructions of the full size will be provided and exhibited in different parts of this public repository, of all such new mechanical inventions as are applicable to the common purposes of life.
>
> Every consideration unites in showing how highly important it must be to the progress of real improvements to have some general collection of useful mechanical contrivances, constructed on the most approved principles and kept constantly in actual use, to which application can be made as to a standard, in order to determine whether the failure of experiments be owing to errors in principle, or to the mistakes of workmen employed in the construction, or to those of the servants intrusted with the management of the machinery.
>
> How useful, also, would such a repository be for furnishing models and for giving instruction to artificers who may be employed in imitating them!

When we read the proposals of Count Rumford as to the organization of the Royal Institution, we see that we can have hardly a better guide to-day for founding a museum of science and industry than his suggestions of one hundred and thirty years ago.

PROPOSALS, ETC.

The two great objects of the Institution being the speedy and general diffusion of the knowledge of all new and useful improvements, in whatever quarter of the world they may originate, and teaching the application of scientific discoveries to the improvement of arts and manufactures in this country, and to the increase of domestic comfort and convenience, these objects will constantly be had in view, not only in the arrangement and execution of the plan, but also in the future management, of the Institution.

As much care will be taken to confine the establishment within its proper limits as to place it on a solid foundation, and to render it an ornament to the capital and an honour to the British nation.

In the execution of the plan, it is proposed to proceed in the following manner:

A place having been fixed on by the managers for forming the Institution, spacious and airy rooms will be prepared for the reception and public exhibition of all such new and mechanical inventions and improvements as shall be thought worthy of the public notice, and more especially of all such contrivances as shall tend to increase the conveniences and comforts of life, to promote domestic economy, to improve taste, or to promote useful industry.

The most perfect models of the full size will be provided, and exhibited in different parts of this public repository, of all such new mechanical inventions and improvements as are applicable to the common purposes of life.

Under this head will be included:

Cottage Fire-places, and Kitchen Utensils for Cottagers.
A complete Kitchen for a Farm-house, with all the necessary Utensils.
A complete Kitchen, with Kitchen Utensils, for the family of a gentleman of fortune.
A complete Laundry for a gentleman's family, or for a public hospital, including Boilers, Washing-room, Ironing-room, Drying-room, etc.
Several of the most approved German, Swedish, and Russian Stoves, for heating rooms and passages.

In order that those who visit this establishment may be enabled to acquire more just ideas of these various and mechanical contrivances, and of the circumstances on which their *peculiar merit* principally depends, the machinery exhibited will, as far as it shall be possible, *be shown in action*, or in *actual use;* and with regard to many of the articles it is evident that this can be done without any difficulty, and with very little additional expense.

Open Chimney Fire-places on the most approved principles will be fitted up as models in the different rooms, and fires will be kept constantly burning in them during the cold season.
Ornamental as well as economical Grates, for Open Chimney Fire-places, will also be exhibited; as also
Ornamental Stoves, in the form of elegant Chimney-pieces, for halls, drawing rooms, eating-rooms, etc.

It is likewise proposed to exhibit *working models*, on a reduced scale, of that most curious and most useful machine, the steam-engine.

Of Brewers' Boilers, with improved Fire-places.
Of Distillers' Coppers, with improved Fire-places and improved Condensers.
Of large Boilers for the kitchens of hospitals, and of Ships' Coppers, with improved Fire-places.

Farther, it is proposed to exhibit, in the repository of the Institution:

Models of Ventilators for supplying rooms and ships with fresh air.
Models of Hot-houses, with such improvements as can be made in their construction.
Models of Lime-kilns, on various constructions.
Models of Boilers, Steam-boilers, etc., for preparing food for cattle that are stall-fed.
Models of Cottages on various constructions.
Spinning-wheels and Looms, on various constructions, for the use of the poor, and adapted to their circumstances, together with such other machinery as may be useful in giving them employment at home.
Models of all such new-invented Machines and Implements as bid fair to be of use in Husbandry.
Models of Bridges, on various constructions; together with *models of all such other machines and useful instruments as the managers of the institution shall deem worthy of the public notice*, and proper to be publicly exhibited in the repository of the Institution.

[3] Taken by F. C. Brown from Volume IV of "The Complete Works of Count Rumford," as published by the American Academy of Arts and Sciences in 1870–75.

It is proposed that each article exhibited should be accompanied with a detailed account or description of it, properly illustrated by correct drawings.

In order to carry into effect the second object of the Institution, namely, *teaching the application of science to the useful purposes of life*, a lecture-room will be fitted up for philosophical lectures and experiments; and a complete *laboratory and philosophical apparatus*, with the necessary instruments, will be provided for making *chemical* and other *philosophical experiments*.

In fitting up this lecture-room (which will never be used for any other purpose than for giving lectures in Natural Philosophy and Philosophical Chemistry), convenient places will be provided and reserved for the subscribers; and care will be taken to warm and light the room properly, and provide for a sufficient supply of fresh air, so as to render it comfortable and salubrious.

In engaging lecturers for the Institution, care will be taken by the managers to invite none but men of the first eminence in science to officiate in that most important and most distinguished situation; and no subjects will ever be permitted to be discussed at these lectures but such as are strictly scientifical, and immediately connected with that particular branch of science publicly announced as the subject of the lecture. The managers to be responsible for the strict observance of this regulation.

In case there should be places to spare in the lecture-room, persons not subscribers will, on the recommendation of a subscriber, and on paying a certain small sum to be determined by the managers, be permitted to attend the public lectures, or any one or more of them.

Among the various branches of science that will occasionally be made the subjects of these public lectures may be reckoned the following, viz. These lectures will treat:

Of Heat, and its application to the various purposes of life.

Of the combustion of Inflammable Bodies, and the relative quantities of Heat producible by the different substances used as fuel.

Of the Management of Fire and the Economy of Fuel.

Of the Principles of the Warmth of Clothing.

Of the Effects of Heat and of Cold, and of hot and of cold winds, on the human body, in sickness and in health.

Of the Effects of breathing vitiated and confined air.

Of the Means that may be used to render Dwelling-houses comfortable and salubrious.

Of the Methods of procuring and preserving Ice in Summer; and of the best principles for constructing Ice-houses.

Of the Means of Preserving Food in different seasons and in different climates.

Of the Means of cooling Liquors in hot weather, without the assistance of ice.

Of Vegetation, and of the specific nature of those effects that are produced by Manures; and of the Art of composing Manures, and adapting them to the different kinds of soil.

Of the Nature of those changes that are produced on substances used as food in the various processes of cookery.

Of the Nature of those changes which take place in the Digestion of Food.

Of the Chemical Principles of the process of Tanning Leather; and of the objects that must particularly be had in view in attempts to improve that most useful art.

Of the Chemical Principles of the art of making Soap; of the art of Bleaching; of the art of Dyeing; and in general of *all the mechanical arts*, as they apply to the various branches of manufacture.

BIOCHEMICAL RELATIVITY

By W. H. MANWARING, M.D.

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ABOUT twenty-five years ago there were introduced into certain fields of physical science radically new basic concepts, particularly in reference to atomic structure and radiant energy. Within one decade the general acceptance of these new hypotheses rendered obsolete a thousand previous conscientious researches. For two decades the new theories have been the accepted basis for a hundred hitherto impossible practical applications. To-day we are apparently at the beginning of a similar basic revolution in certain biological sciences, particularly in those fields of physiology and biochemistry bearing on the phenomena of infection and bodily resistance.

Within the last five years there have been introduced in America, Germany, Russia, France and Czecho-Slovakia radically new immunochemical hypotheses, which, if generally accepted, will render inconclusive half of forty years' accumulated immunological literature. The suggested theory of biochemistry relativity casts doubt on a hundred current therapies, challenges a score of physiological orthodoxies, suggests a new perspective in ecology and genetics, has invaded the field of educational psychology and has already led to at least one previous chemical impossibility.

I

The theory of biochemical relativity was developed to explain the origin and nature of "specific antibodies." Demonstration of the existence of highly specialized biochemical defenses in the bloods and tissue fluids of convalescent and artificially immunized animals dates from the closing decade of the nineteenth century. Serum transfer of acquired immunity, serological conviction for murder, test-tube determination of illegitimacy and cutaneous tests for hereditary idiosyncrasies are a few typical applica-

tions. Since the opening of the twentieth century, the basic problem of immunology has been the determination of the origin, nature and physiological rôle of these highly specialized, defensive serum components.

These specific antibodies have never been isolated in sufficient purity for even approximate chemical analysis. Some of them are known to be associated with the globulin fraction of an immune serum, but whether they themselves are globulins or are simpler chemical substances carried by globulins is still undetermined. No immunochemist to-day can say whether the specific antibody known as diphtheria antitoxin, for example, is monovalent, bivalent or polyvalent for diphtheria toxin, or whether or not it forms a dissociable or a non-dissociable compound with that toxin. Even the postulated therapeutic union of toxin and antitoxin to form an inert, nontoxic colloid is nothing more than a convenient therapeutic metaphor.

II

In developing our historic theories as to the origin and function of these serum defenses, immunologists were handicapped not only by this lack of knowledge as to their chemical nature, but by numerous archaic physiological beliefs.

Early pagan physiology assumed, for example, that ingested foods are ceremoniously baptized with gastric juice and by this baptism forcibly detotemized, compelled to renounce all allegiance to their plant or animal of origin and to swear fealty to human flesh. A thousand pagan therapies and pagan religious ceremonials were based on this gastric psychology. In completely detotemized state the ingested foods were assumed to be absorbed into loyal vassalage to the human soul. Mid-Victorian physiology did little more than translate this ancient pagan physiology into the nomenclature of material science. It assumed without adequate proof that under the influence of digestive enzymes ingested proteins, for example, are completely hydrolyzed or detotemized into non-specific or immunologically inert peptones and amino acids, no undigested protein being physiologically absorbed into the blood stream. For three decades no immunologist questioned the truth of this 100 per cent. perfect Mid-Victorian digestion.

Later immunologists, therefore, were surprised and humiliated by inadvertent evidence that this Mid-Victorian nutritional ideal is never realized, that almost any alien protein applied to any mucous surface is absorbed unchanged into the circulating blood at least in sufficient quantities to stimulate the formation of specific antibodies. A few milligrams of non-toxic bacterial protein, for example, dissolved in physiological salt solution and applied to the vaginal mucosa, cause specific bacterial agglutinins to appear in the circulation at the end of the usual latent or incubation period for agglutinin formation. Within twenty minutes after swallowing raw egg, undigested egg-white is carried to all parts of the body, in sufficient quantities to call forth allergic reactions in distant, locally hypersensitive organs and tissues.

What percentage of a protein meal is thus absorbed unchanged, how much is taken up after the first, second and third hydrolysis and what proportion is not absorbed till complete detotemization into peptones and amino acids no immunologist is prepared to say. Difficulty arises from the fact that gastric acidity alone is known to change protein specificity. Detection in the circulating blood may now require a new anti-serum or a new series of animal tests. With each subsequent hydrolysis one or more new specificities may develop.

III

Early pagan physiology pictured urine as a powerful spiritual force, anesthetizing, paralyzing and enslaving undesirable tissue aliens, casting them into outer darkness. A thousand pagan therapies and pagan religious ceremonials were based on this urinary psychology. Mid-Victorian physiology translated this ancient belief and extended it to include renal excretion of parenteral alien proteins. For three decades no immunologist questioned the existence of this alien-protein-excreting renal function.

Later immunology, therefore, was again surprised and chagrined by the realization that there is no convincing evidence that there is any such renal function. In the albuminaturia following excessive ingestion of raw egg, for example, normal serum albumins and serum globulins appear in the urine, usually without a detectable trace of egg-white. It is, of course, admitted that after massive doses of alien proteins, and particularly with toxic proteins, capillary and glomerular permeability are so increased as to cause mechanical leakage. But this is far from proof of a normal physiologic function.

IV

Medieval Christian physiology assumed that no non-lethal beastliness that escapes excommunication from the human body can resist transubstantiation in the presence of the divine spark vitalizing human blood. A thousand ancient therapies and religious ceremonials were based on this hemic psychology. Mid-Victorian physiology translated this ancient faith into the belief that any foreign protein retained in the animal body is completely hydrolyzed or digested by the living tissues.

For thirty years immunologists placed implicit

faith in this 100 per cent. autopurification. Judge our humiliation, then, when we began to realize that there is as yet no convincing evidence that an appreciable parenteral digestion of alien proteins takes place.

Horse proteins are relatively non-toxic for most experimental animals, a fact that has led to the selection of horses for the production of therapeutic antisera. Injected intravenously, in moderate doses, horse proteins are apparently retained quantitatively in the normal canine circulation for at least six days, as determined by quantitative tests with anti-horse rabbit precipitin. Nevertheless, by the end of four days nearly 90 per cent. of the retained horse protein is so completely denatured as no longer to act as foreign protein in canine tissue. By the end of six days, fully 95 per cent. is so denatured. Or translated into immunological terminology, the retained horse protein is no longer demonstrably antigenic for dogs, though still retaining part of its original antigenicity for other animal species.

By the end of fourteen days, 99 per cent. of the retained horse protein is so completely homologized with canine tissues that it can not be differentiated from certain normal canine proteins by routine precipitin tests. It can be so differentiated, however, by the recently introduced quantitative precipitin graphs. In this highly caninized state at least 25 per cent. of the injected horse protein is demonstrable in the canine circulation at the end of three months. Traces of homologized horse protein have been reported in human blood several years after administration of diphtheria antitoxin.

V

Our present knowledge of protein chemistry is too elementary to warrant attempted hypotheses as to the mechanism of this biochemical adaptation of alien proteins to host tissues. A few very suggestive facts have recently been determined. For example, test-tube conjugation of a single amino acid with a protein molecule may alter its immunological specificity. In other words, it now resembles a protein of another plant or animal species. Two optical isomers of the same amino acid confer different specificities.

Test-tube conjugation with a single lipoid or a single polysaccharide may have similar effects. Conjugation with the same amino acid, polysaccharide or other immunological determinant may render two unrelated proteins so nearly identical, at least in their dominant specificities, as to be indistinguishable by routine precipitin tests. Egg albumen, for example, conjugated with the characteristic polysaccharide recently isolated from the pneumococcus is a successful vaccine against pneumococcus infections in animals.

The adoption of an alien protein by host tissues, therefore, does not necessitate radical changes in internal protein structure. Superficial conjugation with a single host determinant may be all that is necessary. Or a superficial burying of a single alien determinant.

IV

Medieval Christian physiology assumed that as a result of the postulated 100 per cent. excommunication and transubstantiation of alien substances the human body is preserved in the 100 per cent. virginal biochemical purity of Adam. Mid-Victorian physiology endorsed this ancient idealism. For thirty years no immunologist questioned it. It became the basic axiom underlying all our historic immunologic theories.

Specific antibodies were, therefore, of necessity pictured as preexisting normal Adamic colloids, increased or specifically mobilized to overcome toxic or infectious agents. In other words, every specific antibody was pictured a preformed purposeful specific antidote against some human disease, an antidote breathed into the body of the first man or acquired by the postulated miracle of evolution.

During three decades a thousand logical and consistent therapies were developed from this basic faith, hundreds of them tentatively adopted by clinical research, fully 95 per cent. of them afterwards discarded as clinical disappointments.

Theoretical immunologists were soon convinced that there must be something radically wrong in their logic, but few of them dreamed that the error was not theirs, but in the basic Mid-Victorian religio-physiology in which they placed such implicit faith.

VII

Later immunologists have been forced to the reluctant conclusion that this faith is unfounded, that no man is 100 per cent. biochemically perfect. He is but an organized colony of dominant human colloids, biochemical echoes of ancient and medieval infections, ceremoniously adopted personal diseases and incompletely homologized undigested dinners. For the first time in history, therefore, it was conceivable that specific antibodies might not be hereditary specific antidotes, but might be retained modified alien entities or partially dehumanized human proteins—hybridization products between toxic or infectious agents and host tissues. This is the tentative basic hypothesis of the newer immunology.

Probably the most convincing evidence that there is at least an element of truth in this futuristic concept is obtained from the recent realization of a previous impossibility, successful test-tube syntheses of specific antibodies, by simulating the postulated biochemical hybridization in the test-tube. By incubating diph-

theria toxin with normal serum, for example, or with individual serum proteins, either alone or in the presence of commercial enzymes, at least four different specific diphtheria antitoxins have been reported within the last three years. One of these is already patented in Germany. By the same or similar technique scores of artificial specific precipitins for plant and animal proteins have also been prepared. Artificial specific agglutinins for pathogenic micro-organisms. At least one synthetic bacteriocidal antiserum.

VIII

Of course, there is as yet no proof that any of these synthetic antibodies are identical with the natural antibodies formed in the animal body during the process of immunization. But there is suggestive evidence that, in time, artificial antibodies even superior to those formed by nature may be synthesized in the chemical laboratory—another blow to Mid-Victorian idealism.

By incubating diphtheria toxin with certain normal serum proteins, for example, two different artificial diphtheria antitoxins have been reported. With other serum proteins, however, the same observers obtained, with the same technique, not the expected antitoxins, but new toxins of exalted virulence and altered specificity. There is convincing evidence that this supertoxin synthesis also takes place in the animal body. With a proper mixture of the antitoxin-synthesizing and supertoxin-forming proteins, the resulting synthetic product is physiologically and therapeutically inert. Artificial antisera superior to those formed during natural immunization might conceivably result from an initial removal of the toxin-augmenting factor from normal serum.

IX

The newer immunology is not merely concerned with protective antibodies, but is equally interested in possible applications of biochemical hybridization to pathogenic micro-organisms.

It has long been known that celloidin particles suspended in dilute protein solutions undergo changes in electropotential, presumably due to the mechanical formation of superficial or interface protein films. In the presence of alien proteins, bacteria undergo similar changes. The bacteria may even acquire a slight agglutinability with specific precipitins for the environmental proteins. That a more radical hybridization than the postulated mechanical formation of superficial proteins films is possible is shown by growing the same micro-organisms for several generations in dilute proteins. By the eighth to twelfth generation in 10 per cent. horse serum, for example, the mechanically acquired precipitin agglutinability of typhoid bacilli is increased twenty fold. At the same time the bacilli completely lose their initial susceptibility to agglutination with ordinary typhoid agglutinin.

Presumably similar hybrid specificity develops in the animal body—recently published experiences with the causative agent of a certain form of canine distemper, for example. This distemper is readily transferred to ferrets. A sublethal dose of the splenic pulp of an infected dog is a successful canine vaccine against this disease at present extensively used in England. Similarly, a sublethal dose of infected ferret pulp is a successful vaccine for ferrets. But neither of these pulps immunizes or appreciably immunizes the opposite animal species. Apparently the common causative agent is so altered, not only superficially but in internal protein specificity in the two animal species, as to become, for all practical purposes, two immunologically distinct viruses.

A hundred clinics and research laboratories are today inspired by the hope that by test-tube simulation of this postulated protein hybridization new successes may follow in the hitherto discouraging field of vaccine therapy and serum therapy.

The newer immunology introduces equal uncertainty into current theories of filterable viruses and bacteriophage. It suggests a hitherto unpostulated etiology for senility and other degenerative diseases. It tends to make logical numerous currently unacceptable heresies as to cancer, tissue transplantation and hereditary idiosyncrasy. Unfortunately, it also suggests a hundred hitherto unexploited quackeries.

X

In outlining the present trend in immunological research I have, of course, passed beyond the boundary line of adequately demonstrated fact into the uncharted field of the research pioneer. One new basic fact in this field may render illogical every alleged fact I have presented.

For example, let us suppose that some future Avery or Landsteiner proves that egg white owes its immunological character to some superficial fowl-determinant—a lipoid, polysaccharide or amino acid, for example. Let us suppose he proves that this dominant determinant is dissociated from the relatively inert colloid molecule in the gastrointestinal tract and is absorbed into the blood stream. Let us further supposed this absorbed determinant now conjugated with some normal serum protein. There might thus be synthesized in the blood stream an atypical human colloid which few immunologists could distinguish from egg white by routine serological tests. Every alleged fact herein reported regarding the apparent gastrointestinal absorption of undigested egg white becomes obsolete.

XI

To theoretical immunologists the present transitional stage is the most interesting period since Pasteur and equally pregnant with potential clinical victories. To applied immunology, however, it is a period of humiliation, loss of faith in the guiding axiom of our forefathers, a new faith not yet sufficiently grounded for clinical application. A chaos in certain immunological specialties, with few immunotherapeutists "certain in their own minds whether they should be enrolled in future medical archives as honest empiricists or as ignorant charlatans." It is little comfort for them to realize that the basic guilt is not theirs, but rests in the archaic physiology in which they placed such implicit faith.

Above all the present is the dawn of a new perspective in American philanthropy and in American research administration. During the last three decades these agencies have made lavish provision for what the coming generation will inevitably regard as superficial pseudoresearch in immunology, feverish clinical application of unproved physiological hunches. At the same time, they have made negligible provision for the basic theoretical work by which alone the truth or falsity of the accepted postulates might have been established. The recent quarter million dollar grant to an American medical school for basic theoretical research, with the specification that the grant must not be used for purely practical applications of present knowledge, heralds the dawn of a new efficiency in conventional medical research.

A NEW METHOD OF DEEP SEA OBSERVATION AT FIRST HAND

By Professor HENRY FAIRFIELD OSBORN

HONORARY PRESIDENT OF THE NEW YORK ZOOLOGICAL SOCIETY

IMMEDIATELY on the receipt of a cable announcing the first successful descent of the Barton bathysphere I cabled to Director Beebe for a brief official report to be published in SCIENCE.

This is the thirteenth expedition of the Department of Tropical Research of the New York Zoological Society under the direction of William Beebe. It is the fifth year of oceanographic research of this department, and the third season at the Bermuda Oceanographic Station at Nonsuch Island. In the year 1928 the twenty-five acre island of Nonsuch, formerly a health and quarantine station erected by the Bermuda government, was placed at the disposition of the Zoological Society for oceanographic research. The seasons of 1928 and 1929 were devoted to the study of both the shallow and deep water fauna.

The buildings at Nonsuch were "transformed . . . into a comfortable and efficient Marine Zoological Station. The two large buildings were practically new and in perfect condition. The three large rain water tanks were overflowing." The relations with the government were excellent. "We were given every assistance, even to having the wreck of a large tug raised in St. George's Harbor, towed across Castle Harbor and sunk near our landing-place, forming a perfect breakwater for protection in rough weather. We had an excellent outfit both for laboratory work, shallow water investigation, and deep-sea trawling. Our electric light plant furnished light for sixty-odd bulbs, a frigidaire, aquarium pumps, etc. A pumping engine at the landing-place furnished three hundred gallons of salt water an hour for our aquariums."

The regular staff under William Beebe included seven assistants and from time to time was aided by Dr. J. Newton Harvey, Dr. C. J. Fish, Dr. Henry P. Bigelow, Professor William K. Gregory and other visiting experts.

In the recent report of the Zoological Society it is stated: "We secured over two hundred species of shallow water fish, about two thirds of the entire fish fauna of Bermuda, and gathered much material for life histories. The midwater depths—an area which we found most difficult to study—yielded many strange organisms. The deep-sea fish were taken from a restricted locality, five miles off shore, eight miles in diameter, and one half mile to one mile below the surface. They were collected in the course of five hundred and twenty-eight hauls, and in abundance and specialization surpassed our utmost expectations."

SEASON OF 1930

Although the most modern trawling devices were used and diving methods at shallower depths were highly successful, for the two seasons past Director Beebe has felt it of great importance to be able to carry on observations at greater depths. Mr. Otis Barton and the director have been working for two years on various problems of deep sea diving, at first studying a cylinder but finally designing a sphere or diving tank, illustrations of which have already begun to appear in the scientific reports from the Station. Director Beebe's own report of June 21, 1930, is as follows:

Director William Beebe and Mr. Otis Barton have just completed a number of dives in a deep sea chamber or bathysphere in the open ocean to a depth far beyond where any scientific observations at first hand have ever been made. This bathysphere was designed for and financed by Mr. Barton, who in frequent consultation with Dr. Beebe, has worked on it for a year. The barge from which the dives were made was kept anchored off Nonsuch Island where the New York Zoological Society Oceanographic Expedition has its headquarters, and the descents were made in the open sea in connection with and within the limits of the area of intensive research which Director Beebe has carried on for two years past, 1928–1929.

The length of cable at the greater depths was checked and rechecked both by hydrographic meter-wheel and by measuring off and marking one hundred foot lengths of the cable, the difference between these methods being two feet in one thousand four hundred and twenty-six.

On June 6th a descent was made to 803 feet, and on June 11th to 1,426 feet, or beyond a quarter of a mile, with both Beebe and Barton in the bathysphere. The sphere is 57.3 inches in outside diameter, and 1½ inches thick, and at the greatest depth withstood a pressure of 652 pounds to the square inch, or a total of 3366.2 tons on the whole surface. The exact locality was 32° 16′ No. Lat., and 64° 39′ West Long., five miles south of Nonsuch Island, Bermuda.

Fifteen dives have been made altogether, three to a depth of 800 feet. At Mr. Barton's own wish he took charge of the telephone communication and the supervision of the vital instruments and chemicals, while Dr. Beebe carried on ocular and instrumental observation at the window and controlled the depths. The more unusual fish and the extreme spectroscopic readings were also observed and confirmed by Mr. Barton.

The two most surprising phenomena were, first, the abundance of life observed, and the clarity and certainty with which it could be seen and identified, and second, the blue brilliance of the watery light to the naked eye, long after every particle of color had been drained from the spectrum. Another unexpected fact was the presence of fish and invertebrates at these upper levels which, in trawling nets, have been taken only hundreds of fathoms lower. At 700 feet the spectrum, as seen close against the quartz window, was quite devoid of color, the lightest portion being at the 510th wave-length. The last color to disappear was violet, which, many feet above, had completely overlaid the blue.

The visual degeneration of the spectrum was read every fifty feet, and rechecked on different dives and by both divers, and the radical color alteration in known species of fish agreed with the shifting spectrum. An intensity meter was read in connection with the spectroscope.

A strong, electric search-light illuminated the outside water to a distance of many feet, a bag of decayed fish and baited hooks served as a lure, an outside thermometer was easily read, and perfect telephone communication and dictation were carried on without interruption.

Luminous fish and shrimp swam close to the quartz window, about a dozen species of true bathypelagic fish being identified and seen again and again. Among these were *Myctophum, Diaphus, Serrivomer, Idiacanthus, Stomias, Leptocephalus, Cyclothone* and *Argyropelecus*. Puzzling results of the trawling nets were explained, and every possible ecological fact noted and dictated.

A second very important phase of the work proved to be dangerous but exceedingly interesting. This was to lower the bathysphere in shallow water, and as the guiding vessel slowly drifted seaward, to do contour exploration down the Bermudian insular shelf. The risk was the possibility of suddenly sighting a wall of reef too near to be cleared by reeling the sphere quickly upward. Four such descents, to a maximum of 350 feet, yielded unexpected results, revealing an entirely new fish fauna at these offshore depths and opening an absolutely new future field, for the study of the unknown bottom life connecting the shore with the deep sea faunas. The most notable thing about the recognizable shore fish was their great average size.

The only dive when Beebe and Barton were not together in the bathysphere was Dive Number 8, when General Assistant John Tee-Van and the technical associate Gloria Hollister went down to 400 feet and made many interesting observations.

Great credit should be given to Assistants Tee-Van and Hollister for their days of recording work on the deck of the barge. Mr. Tee-Van had full charge of the deck crew and the hoisting machinery and carried on without accident or mistake. Miss Hollister received and correctly and instantly transmitted the scores of orders and observations, contending often with bad static and with confused, over-enthusiastic diction from a quarter of a mile beneath the surface.

The satisfactory margin of safety and the ease and accuracy of observations of fish and other bathypelagic organisms have ensured the advisability of the continued use of the bathysphere for another year.

Nonsuch Island,
June 21, 1930

SCIENTIFIC EVENTS

THE SCIENTIFIC LABORATORIES AND UNIVERSITY ASSISTANTS IN ITALY

PROFESSOR ERMANNO FIORETTI, in an address before the Italian Chamber of Deputies, has called attention, as reported by the correspondent of the *Journal* of the American Medical Association, to some problems of the Italian universities which are awaiting solution, namely, the mode of functioning of the scientific laboratories and the working conditions of the university assistants. The speaker emphasized that the university laboratories should receive larger appropriations, as at present they have not adequate resources for the researches that they are called on to conduct in the interest of scientific progress. Recently there was organized in Italy a campaign against experimental studies carried out on animals, and at a meeting in Rome of the Society for the Protection of Animals, which was attended by many Italian and foreign women, a protest against vivisection was launched. But, Professor Fioretti explained, experimental studies are the very basis of the progress of medical science and certain discoveries (for instance, that of Luciani on the function of the cerebellum) would not have been made without the aid of vivisection. It is necessary, however, that vivisection be well controlled and be carried out solely in authorized institutes. According to the speaker, reducing the number of Italian universities, as has been suggested in some quarters, should not be considered. That is the opinion held also by the head of the government. But there is need of distributing the various faculties in such a manner that there shall be fewer faculties of medicine but provided with greater resources than at present.

The university assistants, Professor Fioretti stated, have not only the duty of assisting in scientific researches and laboratory studies but also the complex task of directing the young students and starting them in their laboratory work. It is necessary, therefore, to consider their living conditions, in order to check the exodus of young men from the scientific institutes and the present scarcity of university assistants. In addition to giving them more pay there is need also of guaranteeing the stability of their career, which is at the mercy of the incumbent in the professorial chair, who may dismiss at his pleasure young men who have had years of experience as assistants. These conditions lower the scientific and didactic performance of the assistants, as is evident also from the results of the state examinations for admittance to the practice of medicine, which this year have shown thirty per cent. of failures. According to Professor Fioretti, the university career, which is long, should be shortened, so that there will be more chairs available for the young professors.

EXPEDITION OF THE DANA

THE *Dana* dropped anchor at Plymouth on June 22 on the conclusion of a two years' oceanographical cruise, which, according to a correspondent of the London *Times,* may prove to be the most important of its kind since *H.M.S. Challenger* returned from her famous quest in 1876. She had anchored at Plymouth on her outward journey precisely two years previously, on June 20, 1928.

The ship is the Royal Danish research ship *Dana,* purchased in 1921 and adapted by the Danish government for oceanographical research. She is "sister" to the *George Bligh* and the *Explorer,* research ships of the English Fisheries Department and the Fishery Board for Scotland, respectively. The cruise was not her first, nor is it likely to be her last, but it is improbable that, for some time to come, she will again undertake so long and extensive a voyage.

The leader of the expedition is Dr. Johannes Schmidt and the commander of the ship Captain G. Hansen. The expenses of the enterprise are shared between the Danish government and the Carlsberg Foundation, whose generosity to science is a household word in Denmark, and the expedition is under the direct patronage of Prince Valdemar of Denmark, the youngest brother of the late Queen Alexandra. The *Dana* left Copenhagen on June 14, 1928, and is expected to return to her home port in a few days, after calling, at the invitation of the Government of the French Republic, at Boulogne.

Although the route of the expedition was largely dictated by Dr. Schmidt's desire to study the eels, the main purpose of it was a general investigation of the oceans, and throughout the voyage the oceans have been studied from every point of view by means of the most up-to-date apparatus of marine research—apparatus undreamed of in the days of the *Challenger.* The *Dana* is equipped with echo-sounding gear, by means of which a large number of soundings have been taken; water samples have been taken at various depths from the surface to the bottom, and the temperature and chemical composition of the water at these depths observed and recorded. Collections have been made throughout of the abundant planktonic life of the sea and of the larger marine fauna, down to the greatest depths.

The full results of the expedition can not be known for years, because the mass of material collected will take years of work by many investigators to sort, identify and tabulate. In fact, it is only now, when this two years' cruise has reached an end, that reports are coming forward on the material collected in the cruise of the expeditions of 1920–22, by means

of which Dr. Schmidt established the facts of the life history of the Atlantic eels. There can be no doubt, however, that the voyage of 65,000 sea miles, from Copenhagen across the Atlantic, through the Panama Canal, to Tahiti, New Zealand and Australia, thence to the Dutch East Indies and China, across the Indian Ocean to East Africa, round the Cape and thence through the Straits of Gibraltar into the Mediterranean—where Dr. Schmidt was determined to check, by means of his most up-to-date apparatus, the findings of previous expeditions conducted by him in that sea—and finally back to her home port, will prove to have furnished contributions of the utmost importance in the science of the oceans.

THE SOLAR ECLIPSE EXPEDITION OF THE U. S. NAVAL OBSERVATORY

FURTHER details in regard to the expedition to observe the total eclipse of the sun on October 21 by the U. S. Naval Observatory have been given out by the Navy Department. The sun will enter the shadow at 9 o'clock in the morning, and be totally obscured for ninety-three seconds.

The expedition will leave Washington on July 19 and will sail from San Francisco on July 31 on the steamer *Sierra*, arriving at Tutuila, Samoa, on August 13. The following investigators will comprise the party:

Commander C. H. J. Keppler, in administrative charge; Commander Keppler headed the Navy's expedition which observed the solar eclipse of May 9, 1929, from the vicinity of Iloilo, Philippine Islands.

Lieutenant H. C. Kellers, Naval Medical Corps, who was a member of the naval eclipse expedition at Sumatra in 1926 and also of the 1929 expedition. Lieutenant Kellers will be medical officer and in charge of meteorological observations, and, at the request of the Smithsonian Institution, he will collect specimens of the island fauna and flora.

Professor S. A. Mitchell, director of the Leander McCormick Observatory at the University of Virginia, who will conduct spectrographic work.

Kempton Adams, assistant to Professor Mitchell.

Professor Ross W. Marriott, Swarthmore College astronomer, who will carry out coronal photography with a 63-foot camera and make observations to test the Einstein theory.

Dr. Weld Arnold, of the American Geographical Society, assistant to Professor Marriott.

J. J. Johnson, of the California Institute of Technology, who will make photometric observations.

B. P. Sharpless, junior astronomer at the Naval Observatory, who will do coronal photography with a 15-foot camera and other smaller ones.

Dr. T. A. Jaggar, Jr., of the Volcanic Observatory at Hawaii, who will study volcanic and seismic conditions on Niuafou Island.

In addition to this scientific personnel eleven enlisted men of the Navy and Marine Corps will go to assist in construction work and in taking observations. These men, selected from the personnel of the battle fleet, sailed from the Mare Island Navy Yard aboard the mine sweeper *Tanager* on June 25 and will arrive at Samoa about August 9. The enlisted personnel includes a rigger, an optical repair and instrument man, a carpenter to construct large cameras, an expert photographer, two general assistants, two radio operators, two cooks and an interpreter.

About 115 boxes and cases of scientific instruments and equipment have been shipped to Tutuila, besides camp equipage and food supplies sufficient for twenty men for sixty days, and about 8,000 board feet of lumber for the construction of various cameras. The largest of these cameras will have a focal length of sixty-five feet and include a photographic developing room.

Niuafou is a very small volcanic island about 300 miles west southwest of Tutuila. Primitive conditions prevail and only two white men and 1,100 natives live there.

About thirty craters are on the island. Many of them have recently been active, and a major eruption occurred in June, 1929, which destroyed one of the two villages. There are no good anchorages and only one precarious landing place.

THE LIFE SCIENCES BUILDING OF THE UNIVERSITY OF CALIFORNIA

THE work of moving thirteen departments from eleven wood-frame buildings into the new fireproof and earthquake proof Life Sciences Building at the University of California is practically completed. This building was the first to be built on the Berkeley campus under the provisions of the state bond issue of 1926, and cost $2,000,000.

The Life Sciences Building, said to be the largest academic building in America, is five stories in height, has a floor area of 321,000 square feet and provides 60 per cent. more space than the eleven buildings which it replaces, combined.

Among the old buildings which the completion and occupation of the Life Sciences Building will leave empty, are: Agricultural Chemistry, erected in 1908; Anatomy, erected originally as shops for the department of mining; Botany, erected in 1898; Budd Hall of Biochemistry, erected in 1896; California Museum of Vertebrate Zoology, a temporary structure of wood and corrugated iron which has been in service for twenty-one years; East Hall or Zoology Building, erected in 1898; Home Economics, a wooden building erected in 1916; Hygiene and Pathology, erected in 1913; Psychology Building, erected in 1898; Spreckels Physiology Laboratory, erected in 1903.

As soon as possible the work of tearing down the old buildings will be started and their sites will be landscaped or used for other purposes. The site of Budd Hall will be utilized for the Eshleman Memorial Building to house student publications. Aside from these eleven structures, other obsolete buildings which new construction is replacing are: the old student infirmary, replaced by the new $450,000 Cowell Memorial Hospital; the old power house, replaced by a new $400,000 heating plant capable of supplying the augmented needs of the campus.

The Life Sciences Building, in addition to its more than 400 laboratory and office rooms and the Museum of Vertebrate Zoology, has an auditorium seating 500, and a library with a capacity of 90,000 volumes.

HONORARY DEGREES FROM YALE UNIVERSITY

THE citations on the occasion of the conferring of honorary doctorates of science at the recent commencement of Yale University were as follows:

EDWIN GRANT CONKLIN, SC.D.

Professor Phelps: Biologist. Bachelor of Science, Ohio Wesleyan University, 1885. B.A. 1886, M.A. 1889. Ph.D. Johns Hopkins, 1891, and recipient of many honorary degrees. Held the chair of biology at Ohio Wesleyan, and since then has been professor of zoology at Northwestern, University of Pennsylvania, and since 1908 at Princeton. He is a member of many learned societies in Europe and in America. His publications are numerous and important; including "Heredity and Environment," "Mechanism of Evolution," "Direction of Human Evolution," "Biology and Democracy" and other works on heredity and education. The range of his interest is as wide as life itself. He is a great scholar and a great citizen. His investigations have been largely in the fields of cytology, particularly cell division, and of embryology, both descriptive and experimental. In his work on the development of mollusks and ascidians he has followed closely the changes from the single-celled egg through all successive cell divisions, to the formation of the principal organs of the adult body. His work has all been done with great attention to detail, with extraordinary accuracy and with completeness. His papers have always been finished with artistic perfection. He has been willing to spend a fair portion of his time in making his science comprehensible to the general reader. In this he has been most successful, as his popularity as lecturer and author testify.

President Angell: Everywhere recognized as one of the distinguished biologists of your time, you possess two qualities rarely conjoined in eminent scientific men—a genius for sound and exhaustive work of the greatest precision, issuing in fruitful and striking discoveries, combined with a broad and profound outlook on the whole field of biological science, especially in its remoter human implications, about which you write so lucidly that even the interested layman may understand. In recognition of these remarkable gifts, Yale University is proud to confer upon you the degree of Doctor of Science, admitting you to all its rights and privileges.

CHARLES SCHUCHERT, SC.D.

Professor Phelps: One of the most distinguished of the scientists of Yale, in the front rank of paleontologists, and the world's leading authority on paleo-climatology. A youth in Cincinnati, while belonging to the younger generation, he was paradoxically a collector of fossils. He taught paleontology in Kentucky, New York and Minnesota, coming to Yale in 1892. He has done work for the U. S. Geological Survey, for the U. S. National Museum, and in 1904 was appointed at Yale professor of paleontology and historical geology, becoming professor emeritus in 1923, since when he has, if possible, worked harder than ever. He may be seen at an early hour every morning entering the Peabody Museum. He is the author of a standard work, "Historical Geological Paleogeography of North America." His services to Yale University have been and are now invaluable. Although his professional interests are concerned with prehistoric time, he is held in the warmest affection by contemporary men; every one who knows him is his friend.

President Angell: You have long served Yale with fidelity and distinction. She has been proud of your leadership in the field of your special study, a leadership which no one challenges. In token of the high respect in which your scientific work is held and in affectionate remembrance of your long years of devoted service to her interests, Yale University gladly confers upon you the degree of Doctor of Science, admitting you to all its rights and privileges.

SCIENTIFIC NOTES AND NEWS

A TRIBUTE to President W. W. Campbell, who retired from office at the University of California on July 1, was paid by the regents at their last meeting. Prepared by Regent Chester A. Rowell, the following resolution of appreciation was adopted: "On the eve of the retirement of President William Wallace Campbell, after nearly forty years of distinguished service to the University of California, the regents hereby record their appreciation of a great scholar, an outstanding administrator and an inspiring character. After a long and notable career as astronomer and director of Lick Observatory, Dr. Campbell came to the presidency at a time of many and difficult problems. Already eminent in the world of intellect and of knowledge, his high ideals, fine spirit, clear vision, decisive judgment and administrative efficiency as an ex-

ecutive have left a permanent record of achievement in the progress of the institution over which he presides. In the midst of complex external problems and great material development, he has never lost sight of the main purposes of a university: the advancement of teaching and learning and the increase of usefulness to its students and to the state. With regret that the time of official retirement has arrived, and with the affectionate hope of many years of happiness and usefulness, the regents tender this tribute of acknowledgment."

DR. HARVEY WASHINGTON WILEY, from 1883 to 1912 chief chemist of the U. S. Department of Agriculture, died at Washington, D. C., on June 30, at the age of eighty-five years.

DR. E. STARR JUDD, of the Mayo Clinic, professor of surgery in the Graduate School of the University of Michigan, was elected president of the American Medical Association at the recent Detroit meeting.

NORTHWESTERN UNIVERSITY has conferred the doctorate of science on Olin H. Basquin, Chicago engineer and one of the organizers of the School of Engineering at Northwestern University, and on Dr. G. Carl Huber, professor of anatomy and dean of the graduate school of the University of Michigan.

THE University of Michigan has conferred on Mr. Frank Leverett, lately glacialist on the staff of the U. S. Geological Survey and staff lecturer on glacial geology at the university, the honorary degree of doctor of science.

HAMLINE UNIVERSITY at its recent commencement conferred the degree of doctor of laws on Dr. Charles Horace Mayo, of the Mayo Foundation.

DR. J. TRUEMAN THOMPSON, professor of civil engineering at the Johns Hopkins University, has been appointed manager of the sixth International Road Congress. The congress, which it is expected will be attended by leading highway engineers, administrators and economists from virtually every civilized country in the world, will meet in Washington from October 6 to 11 at the invitation of the United States government.

DR. EDWIN O. JORDAN, professor of bacteriology at the University of Chicago, has been elected a member of the board of scientific directors of the International Health Division of the Rockefeller Institute.

COLONEL HARLEY B. FERGUSON, Corps of Engineers, has been appointed a member of the Board of Engineers for Rivers and Harbors, to succeed Colonel George B. Pillsbury.

M. CH. FABRY and M. Ch. Maurain have been elected to the council of the National Bureau of Scientific Research and Invention, Paris, in succession to the late M. Pateau and the late M. Sebert.

DR. MARCUS BENJAMIN, the editor of the publications of the United States National Museum, was one of the five recipients of the Medal of Service given for the first time at the recent commencement of Columbia University. The award was made in recognition of Dr. Benjamin's "long years of patient and effective work in his chosen field of endeavor."

DR. THURMAN D. KITCHIN, dean of the Medical School of Wake Forest College for thirteen years, has been elected president of the college. He succeeds Dr. Francis P. Gaines, who resigned to become president of Washington and Lee University.

LYMAN D. PHIFER, associate in botany at the University of Washington, has been named assistant director for the spring of 1930–31 of the university's Oceanographic Laboratories in the upper Puget Sound. He will aid Dr. Thomas G. Thompson, recently appointed to direct the laboratories in the program of scientific research in oceanography which is being outlined. Dr. Thompson is now on an extended European tour studying oceanographic methods in the Mediterranean, Central Europe and North Atlantic laboratories. He holds a traveling fellowship granted him by the Rockefeller Foundation.

AT a recent meeting of the board of regents, the appointment of a new executive committee to govern the University of Michigan Medical School was approved. The directorship of the division of preclinical medicine will go to Dr. Frederick G. Novy, head of the department of bacteriology and a member of the old executive committee. Graduate medicine will be under the supervision of Dr. James D. Bruce, present supervisor of the work. Clinical medicine will be directed by Dr. Udo J. Wile, of the department of dermatology and syphilology. Dr. Harley A. Haynes will have complete direction of the University Hospital and Dr. Arthur C. Curtis, former assistant to the dean of the medical school, now becomes secretary. Dr. Hugh Cabot is said to have resigned from his chair in the university.

DR. EARL W. PHELAN, of Western Reserve University, has been appointed professor of chemistry at the Georgia State Womans College, Valdosta, Georgia.

DR. WALTER R. FIESELER, formerly medical supervisor of athletics at the University of Iowa, has resigned from the faculty of the college of medicine to become associate medical director at the University of Southern California.

AT the University of Cambridge there will be established for three years a temporary professorship of colloidal physics, which in the first instance is to be

held by Mr. E. K. Rideal, of Trinity Hall. The professorship is to be primarily assigned to the faculty of physics and chemistry.

AT the Paris Observatory, M. Fayet, director of the Nice Observatory, and M. Lambert, associate astronomer at Paris, have been appointed astronomers to succeed the late M. Fatou and M. Hamy, who recently retired.

DR. WILLIAM R. MAXON, associate curator of the division of plants of the U. S. National Museum, has sailed for Europe. As a representative of the Smithsonian Institution he will attend the International Botanical Congress to be held at Cambridge this summer. Part of his time will be spent at the British Museum (Natural History) and the Royal Botanic Gardens, Kew, where he will continue preparation of the fern volume for the Flora of Jamaica.

DR. WARREN D. SMITH is conducting a course in geography and geology of the Pacific Basin on the University of Oregon Summer School cruise to Hawaii from June 25 to August 1. During the fall quarter of 1930–31 he plans to visit the west coast of South America.

DR. GEORGE B. RAY, associate professor of physiology in the School of Medicine of Western Reserve University, sailed from New York on July 5 to spend the summer in Germany. From September to March, Dr. Ray will study with Dr. Joseph Barcroft, professor of physiology at the University of Cambridge.

DRS. W. A. ALBRECHT and Samuel Brody, associate professors, respectively, of soils and dairy chemistry at the University of Missouri, have been given a year's leave of absence to be spent in Europe.

A SPECIAL cable dispatch to the New York *Sun*, under date of July 3, reports that a storm in the Gobi Desert, which wrecked his camp and scattered his supplies on June 10, forced the return to Peiping of Roy Chapman Andrews to obtain supplies.

THE annual address before the Kentucky Chapter of Sigma Xi was delivered by Professor Leo E. Melchers, head of the department of botany of the Kansas State Agricultural College. The lecture was illustrated and entitled "Life and Scenes along the Nile." The speaker recently returned from Egypt where he had been making a study of Egyptian agriculture.

THE Huxley Memorial Lecture of the Imperial College of Science and Technology next year will be delivered by Sir A. Smith Woodward, on "Modern Progress in Vertebrate Paleontology."

THE ninety-eighth annual meeting of the British Medical Association will be held at Winnipeg from August 26 to 29.

As a result of the action taken at the first International Congress of Soil Science held in Washington in 1927, the second congress will be held in Russia from July 20 to 31. The first International Congress was held under the joint auspices of the U. S. Department of Agriculture and the American Society of Agronomy. Meetings for the first six days of this year's congress will be in Leningrad and the remaining time will be spent in Moscow. Following the congress, an excursion of 29 days will be made across the soil zones of European Russia, during which members of the congress will have an opportunity to study the soils and visit schools, agricultural experiment stations and farming and industrial enterprises.

THE Second International Pediatric Congress will meet in Stockholm, from August 18 to 21, under the presidency of Professor I. Jundell, of the University of Stockholm. Three main subjects will be considered: (1) The biological effect of direct and indirect ultra-violet irradiation, which will be reviewed by Dr. Hess of New York. (2) The physiological and pathological significance of the thymo-lymphatic system, reviewed by Dr. Hammar of Uppsala, Cattaneo of Milan, Moro of Heidelberg and Mouriquand of Lyons. (3) The psychology and pathology of childhood, reviewed by Gillespie of London, Hamburger of Graz, Krasnogorski of Leningrad and Péchère of Brussels. Other subject will be discussed in various section meetings.

UNDER the patronage of H. M. King Albert of Belgium, it is proposed to hold an International Congress of Historical Geography at Brussels, from August 11 to 14. It is possible, according to the *Scottish Geographical Magazine*, that a meeting may be arranged at Liége, and one at Antwerp, and the date of the congress will coincide with that of the International Exhibitions at Liége and Antwerp, and with the festivities organized in commemoration of the centenary of the independence of Belgium. The president of the congress is Professor H. Van der Linden, of the University of Liége, and the general secretary is Professor F. Quicke, of the Royal Athénée, Brussels. Communications should be sent to the latter at 3 Avenue Saint-Augustin, Forest-Brussels.

THE will of the late Colonel William Boyce Thompson leaves his collection of minerals and carved stones to the American Museum of Natural History, with the provision that the collection shall remain at his residence as long as his widow and daughter reside there, unless permission to remove it is given. The collection is to be designated by the museum as "the

Boyce Thompson mineral collection." The will provides a fund of $20,000 to the museum for preparation of a room or building to house the collection and another fund of $50,000 for the purchase of additions to the collection and for its maintenance. No further endowment is provided by the will for the Boyce Thompson Botanical Institute.

CONGRESS without a dissenting vote has passed the Smoot-Elliott bill authorizing an appropriation of $6,500,000 for the enlargement of the U. S. National Museum.

THE Research Institute of the Lankenau Hospital announces the opening of a Marine Experimental Station at North Truro, Cape Cod, Massachusetts, to extend the study of the chemistry of cell division to marine animals. This was made possible by a gift of land from the L. D. Baker estate and a building the gift of Mr. A. Bein, of Philadelphia.

CEREMONIES in connection with the laying of the cornerstone of the new engineering laboratory of the Westinghouse Electric Company built at a cost of $2,000,000 took place on June 10. As Mr. W. S. Rugg, vice-president of the company, placed the model cornerstone in position, delicate relays controlled by the "electric eye" operated the hoist that swung the actual cornerstone into place. The actual cornerstone, and a model on a crane at the right of Mr. Rugg, exactly followed his movements as he placed the model stone in place on the model building. The laboratory, which will be the largest and tallest arc-welded structure in the world, will contain twenty-five elaborately equipped laboratories for nearly every branch of the electrical industry.

THE *Journal* of the American Medical Association reports that the new School of Public Health and Tropical Medicine was opened in Sydney, on March 6. It will carry on the work of the School of Tropical Medicine, which has been in existence since 1907 at Townsville. It is housed in its own building within the grounds of the university, close to the medical school. Erected at a cost of £35,000, it provides for departments of parasitology, entomology, bacteriology, pathology and chemistry, while sections dealing with physiology, industrial hygiene, epidemiology, vital statistics and sanitary engineering are contemplated. It will be under the control of a council composed of representatives of the commonwealth government and the University of Sydney. Dr. Harvey Sutton has been appointed director. It will provide especially for the graduate training of public-health personnel, but will also include special non-medical courses of school hygiene in the diploma of education and of tropical hygiene in the diploma of anthropology. The courses for the diploma in public health and for the diploma in tropical medicine have already been commenced, and a diploma of tropical hygiene is contemplated. A library to deal with public health and tropical medicine is being built up from a nucleus, previously existing at Townsville, which, it is hoped, will be complete in all Australian aspects.

A NEW zoological institute and a combined physical and chemical institute will be erected at the University of Munich through funds given by the Rockefeller Foundation. The donation makes it possible to abandon a previous plan to provide for the two departments of the university by making additions to the Wilhelminum, the renaissance palace in the Neuhauserstrasse. This plan is said to have met with opposition from Munich artists and friends of art.

THE Chemical Foundation, Inc., has made a gift of $100,000 to the recently created National Institute of Public Health.

THE Rockefeller Foundation has informed the senate of the University of Sydney that it will contribute £100,000 to provide laboratory facilities for the departments of surgery, pathology, bacteriology and allied subjects.

THE acquisition by Columbia University of a Weights and Measures Library containing works from 1520 to the present time and forming what is said to be the most comprehensive collection of volumes on the science of weights and measures in the possession of any educational institution has been announced. The collection is the gift of Samuel S. Dale, of Boston, formerly editor of the *Textile World Record*, an authority on weights and measures, in memory of his father and mother, Thomas and Fanny Dale, of Little Falls, N. Y. The works number between 1,100 and 1,200 volumes, with some 700 pamphlets.

WE learn from *Nature* that the question of the destiny of the Radcliffe Observatory site and buildings has now come officially before the University of Oxford in the form of a decree in congregation. By this it is proposed to accept the offer of Sir William Morris, the purchaser of the site from the Radcliffe trustees, to vest the whole of the property in the hands of a body of trustees, in order that it may be used for the benefit of the Radcliffe Infirmary and the Medical School of the university. The terms of the trust provide that the old observatory building shall be used for the purpose of medical teaching and research, and that the observer's house and garden shall be used as a residence for the director of the institute of research to be constituted.

CONSTRUCTION of an observatory to house a 5-inch equatorial telescope, recently secured by the Panama Canal from the United States Navy, is in progress. The building is being erected on a small hill a short distance to the northwest of the Miraflores filtration plant, and will be a circular structure 14 feet in diameter, with 6-inch concrete wall. It will be topped with a mobile steel dome equipped to travel on a circular track, permitting the use of the telescope toward all points of the compass and facilitating the observation of celestial bodies in all parts of the heavens. The observatory is being established through the efforts of the Canal Zone Astronomical Society, with the assistance of the canal administration, and is to be used for the instruction of students of the Canal Zone high schools and for Panama Canal employees interested in or associated with astronomical societies. Ground was broken for the building on April 11, and it was expected that the work would be completed in June. The position of the center point of the pier on which the telescope will rest is: Latitude 9° 00′ 15″ North; longitude, 79° 35′ 51″ West.

THE European producers of mercury, desiring new uses for the metal, have offered a prize under the following stipulations: (1) A prize will be awarded, under the conditions below, to whoever proves to a commission of the European producers to have found a new use for mercury or its salts, and to have industrially exploited it, the extent of the use being defined as in (3) below. (2) The use should be as yet unknown to the industry, and should be regularly and definitely protected by patent not before January 1, 1930, in Germany and the United States. (3) The application must be important enough to indicate a new consumption of mercury of at least 1,000 flasks during 1930, 3,000 in 1934 and 5,000 in 1935. (4) The prize will be awarded by a commission consisting of the president and vice-president of the European producers and two technicians named by the Spanish Academy of Sciences and the Academy of Italy, or their representatives. The prize will be £5,000 sterling, £1,000 to be paid immediately upon the decision of the commission; £2,000 one year after the condition in (3) above has been confirmed, and £2,000 two years after the condition in (3) has been confirmed and the consumption of the metal estimated practically and confirmed by the commission. (5) The commission may delay the award, reduce its value or prolong the period of offer without giving any reason for its action. (6) The decision of the commission is final without notification of reasons. (7) The complete account of the studies and practical experiments relating to the new application should be presented in quadruplicate, printed or typewritten either in Spanish, Italian, German, English or French, and should be sent, registered, to Mercurio Europeo, Bureau de Repartition, Plaza St., Francois 5, Lausanne, from which further information may be obtained.

TWELVE National Radium Centers have been nominated by the British Radium Commission, as being places where there are medical schools with complete clinical courses and where treatment of patients can be combined with the education in approved methods of radium therapy. The centers are: *England*—Birmingham, Bristol, Leeds, Liverpool, Manchester, Newcastle and Sheffield; *Scotland*—Aberdeen, Dundee, Edinburgh and Glasgow; *Wales*—Cardiff. Loans of radium are being restricted in each area to one hospital selected by the medical faculty of the local university. London has been treated as a separate and special problem, and steps have been taken to organize two centers to carry out special work of general and national importance. Approximately 17 grams of radium out of a possible total of about 22 have been ordered and provisionally allocated by the commission to national centers. Of this quantity, nine grams have already been received from the manufacturers, and, after being tested at the National Physical Laboratory, 6¼ have been delivered to centers and a further 3½ will be going out very shortly. In collaboration with the Medical Research Council and the British Empire Cancer Campaign, a set of "Radium National Forms" for the use of recognized centers has been prepared, in order that the clinical records of all cases treated may be kept on a uniform basis and eventually incorporated in general national statistics.

DISCUSSION

SEA-LEVEL CHANGE NEAR NEW YORK

UNDER the above title Professors A. C. Lane and W. F. Cheney, Jr., in the March 21 issue of SCIENCE call attention to what they term "an erroneous statement" in *Bulletin* of the National Research Council Number 70 entitled "Studies of Mean Sea-level." The wording of their criticism might lead the reader to infer an error in computation which affected the validity of a certain conclusion set forth in that bulletin, namely, that tidal observations at Fort Hamilton, New York, indicate no appreciable change in sea-level during the last thirty-five years. Those familiar with the bulletin in question will appreciate that Lane and Cheney disagree rather with the conclusion itself. Accepting the figures given there, they proceed to deduce mathematically a probable rise of sea-level of 0.0047 feet a year ± 0.06, or as they otherwise state it, a probable rise of about 0.6 feet

per century. This they consider an "appreciable" change. The comments of Lane and Cheney are pertinent from two points of view.

In the first place, the wording of the bulletin while correct is not as precise as it should be, since it is open to the interpretation that the studies there described do definitely indicate some progressive change in mean sea-level, but that the author of the bulletin did not consider such change appreciable. The text of the bulletin should have stated more clearly that the tidal observations give absolutely no proof of any progressive change whatever in the relative levels of land and sea in the last thirty-five years; and further, that if any slight change has occurred it must have been inappreciable, since it is so effectively masked by much larger temporary irregular and periodic changes in sea-level (due to meteorological and other causes) as to be incapable of demonstration.

In the second place, it is of course pertinent to challenge the fundamental conclusion itself, as correctly worded in the foregoing sentence. This Lane and Cheney have in effect done. The reader should remember that both in the communication of these authors and in the text to which they refer, the expression "appreciable change in sea-level" is really a short-cut for the phrase "progressive, cumulative change in sea-level continuing over a significant period of time and measurable in terms of inches or feet per century." This is clear from the context in both cases; and indeed the existence or non-existence of such a progressive change is the only point at issue. All agree that there are short-time fluctuations of sea-level, both irregular and periodic, which render difficult the determination of slow progressive changes of level in a given direction for long periods of time.

With the mathematical calculations of Lane and Cheney the present writer would find no fault, but he can not accept their conclusion that the figures indicate a progressive rise of sea-level. It was clearly foreseen that the tidal data set forth in the bulletin were mathematically capable of interpretation as an indication of rising sea-level, and both this fact and the objections to such an interpretation were set forth with some fulness. On this point the present writer can not do better than quote extracts from pages 37 and 38 of the document[1] in question, retaining reference to figures and tables in the bulletin for sake of clarity in the text as quoted:

Casual inspection of the curve showing the average mean sea-level for each year of this period might lead one to conclude that there has been a progressive rise of mean sea-level or a progressive subsidence of the land at this point. Thus the yearly mean sea-level repeatedly sank below the datum plane to which these readings are referred (supposed mean sea-level at Sandy Hook) during the years 1893–1913; but it has never fallen that low since 1913. Again, as shown in Table 9, the average position of mean sea-level for the first five years of this period is lower than for any subsequent five-year period.

But the curve shown in Fig. 14 and the data tabulated in Table 9 must be interpreted in the light of our present knowledge of the marked fluctuations to which mean sea-level is subject owing to astronomical, meteorological and other conditions. The curve itself is sufficient evidence that mean sea-level varies greatly from year to year, and indicates that these variations are apparently highly irregular and unsystematic. The work of W. Bell Dawson and H. A. Marmer has shown that there are periodic variations in mean sea-level, and that if we average the records for a number of years so as to eliminate the discordant effects of great annual variations, there will appear some evidence of a four-year period, and also of a nine-year period. Thus the average position of sea-level at a given point during one complete four-year period may differ from that of another four-year period by as much as two inches, even when no real change in the general elevation of land or sea is taking place. Similarly the nine-year period may cause fictitious appearance of progressive emergence or submergence amounting to an inch or more. When we have available accurate tidal records extending over very long stretches of time, we may discover that there are other and longer periodic fluctuations of sea-level due to astronomical and meteorological causes.

When we examine the curve of Fig. 14 and the data tabulated in Table 9, with the known fluctuations of mean sea-level in mind, we see that they afford no proof of any progressive change in the general level of land or sea. The annual variations, the four-year variations and the nine-year variations shown by the curve are all within the limits of variations normally due to astronomical and meteorological causes. The more or less steady rise of sea-level from 1912 to 1919 was followed by a more or less steady fall from 1919 to 1926. As shown in Table 9, the average position of mean sea-level for the first five years of the thirty-year period 1898–1927 differed from that of the last five years by only 0.01 foot, or little more than one tenth of an inch. Obviously, there is nothing thus far revealed in the Fort Hamilton record which can be taken to indicate a progressive rise of the general sea-level, or a progressive subsidence of the land.

One need only add that in 1925 Marmer wrote: "It may therefore well be that the apparent subsidence of the coast from 1909 to 1919 represents but the rising phase of a fluctuation in sea-level with a period of something like twenty years."[2] The drop

[1] Douglas Johnson, "Studies of Mean Sea-level," *Bull. Nat. Res. Council* No. 70, 50 pp., 1929.

[2] H. A. Marmer, "Sea-level Along the Atlantic Coast of the United States and its Fluctuations," *Geogr. Review*, 15: 438–448, 1925. See p. 447.

of sea-level from 1919 to 1926 referred to above may afford some support for Marmer's twenty-year period, a support not necessarily negatived by the higher level of 1927. Time will give the answer to this phase of the problem, as to others.

Should continued tidal observations at Fort Hamilton demonstrate the reality of a very slow rise of sea-level, thus far masked by the combination of irregular and periodic variations of the ocean surface, we would still be far from the demonstration of a general progressive rise of sea-level or subsidence of the land. Such rise might be but the upward swing of a periodic fluctuation extending over a span of time longer than any yet determined. Accurate tidal records do not go far enough back to enable us to detect a thirty-five-year or longer period. Again, the rise might be both local and temporary, due to changes in the form of shores and channels, as set forth on page 39 of the bulletin previously cited. Comparison with other tidal stations would in time reveal the nature of the rise.

Meanwhile we must recognize the following pertinent facts. (*a*) Although mean sea-level is the best known datum from which to reckon slow progressive changes in the relative levels of land and sea, it is itself an uneven surface. Furthermore, it is an extremely sensitive surface, subject to both irregular and periodic changes in altitude some of which extend over decades. (*b*) Hence the determination of slow progressive mean sea-level changes, far from being the simple operation it was once considered, is a peculiarly delicate and difficult task. (*c*) While precise tidal observations are now available for a period sufficiently long to show the absence, during such period, of any pronounced rate of subsidence, like the one or two feet per century commonly attributed to the Atlantic Coast, the occurrence of a much slower change (what the writer has called an "inappreciable" change) can be neither affirmed nor denied until many more years of precise tidal observations are at our disposal. The writer does not deny the possibility of a slight or slow change, and hopes some one may take sufficient interest in the subject to finance the maintenance of a tidal station in some position suitable for the required critical observations.

With the suggestion of Lane and Cheney that the whole question deserves further consideration we are in hearty accord. Aside from its scientific interest the problem of slow sea-level changes enters into practical affairs where the engineer must foresee increased wave activity on a subsiding coast, where title to submerged property depends on whether the submergence was due to natural or artificial causes and in other circumstances which need not be considered here. Hence every contribution to this difficult problem is doubly welcome. But it is not clear that the further suggestion relating to meanders in streams flowing at and below tide-level is pertinent to the question at issue. Even if such meanders indicate past submergence (which remains to be demonstrated), it is difficult to see how they could throw any light on slow changes in sea-level supposed to be taking place at the present time.

DOUGLAS JOHNSON

COLUMBIA UNIVERSITY

ON GENUS AND SPECIES MAKING

PROFESSOR NEEDHAM'S objections to certain lengthy generic names[1] appears to have brought forth a flood of comment, mostly reactionary, not only concerning the length of generic names but also relative to the alleged overmultiplication of generic names.[2] More recently Dr. Hubbs[3] has hastened to the defense of the systematic zoologist. As a systematic zoologist working with the invertebrates I venture to offer a few comments, not only in the matter of generic names, but also in the treatment of specific variation. For the past hundred or more years the work of defining new genera has been in progress. At first these groups were founded upon characters contained only in the external parts of the animals, principally the shells of mollusks and other invertebrates. As the internal organs began to receive attention, new characters or combinations of characters were discovered which resulted in further splitting of older names, and in advancing subgenera to generic rank. Any one who has followed the development of the classification of the land Pulmonata under the epoch-making studies of Dr. Pilsbry, in which many new genera and higher groups have been diagnosed, can not but admit that the subject has been made clearer by the addition of the many generic groups.

This division into genera is a refinement of classification made necessary by our advance in knowledge of the structure of animal life. After all, classification is only for the interpretation of natural laws, including the separation of the various types of animal life into groups for purposes of use in different lines of investigation, and for this purpose nothing has been suggested that is in any manner an improvement over the modified Linnaean system now in use. Degrees of differentiation are well indicated by classes, orders, families and genera. Suggestions have been made from time to time that numbers or symbols would be an improvement, but every systematist knows full well that such systems would be totally out of the question for practical use.

[1] SCIENCE, 71: 26–28, 1930.
[2] SCIENCE, 71: 215–218, 1930.
[3] SCIENCE, 71: 317–319, 1930.

A fact of great significance in this discussion appears to have been overlooked, that this seemingly great overmultiplication of generic names may be of a transient nature, for in many groups of animals our knowledge is still so meager that no one can predict what the final groupings may be when the structure of all species is known. Dr. H. B. Baker, in his study of the minute land snails of America, has pointed out this aspect of the case, and states that until all members of the larger groups have been studied, the different divisions must be treated as genera, which may be reduced to subgenera in the light of later study. This is equally true of the fresh-water pulmonates, in which group anatomical characteristics of great significance are being found, and the newer groupings must be kept separate as genera until more of the species have been investigated. To include many of these as subgenera would be a contravention of the facts. I can not see how we are to avoid this multiplication of genera if we are to make substantial progress in our interpretation of invertebrate life. No difficulty is encountered in using the newer classifications in teaching students who have not already absorbed the older view-points. The greatest difficulty appears to be among the workers who have for years used the older forms of classification and who find it difficult to adjust themselves to the newer view-point.

The multiplication of names is not alone confined to genera. Old species, found by careful study to be composites, are being split into two or more species. The study of environmental influences is adding to the number of subspecific names. The latter feature, carried to its logical conclusion in a recent work on fresh-water mollusks,[4] has called forth the same sort of criticism as that for the division of genera.[5]

What constitutes a species is governed so largely by personal opinion that no two authorities are likely to agree on the subject. The writer has made it a rule to consider a group of individuals which are separated from all other groups by some definite combination of characteristics, without intergrading, as species; those that show intergradations as varieties. Geographic races or varieties are for the most part generally accepted without question and need not be discussed. But when an attempt is made to interpret the action of the environment on species, and names are given to these ecological forms, objection is at once made on the ground that they are trivial and should not receive distinct names, but be designated by locality. Such a procedure is obviously impossible for the reason that two or more of these variations may occur in the same region and the reader of a communication would not know which form was referred to.

For the study of animals from the ecological and distributional standpoint these variations resulting from environmental changes must receive names to be used. In many species of fresh-water mollusks, one form may be quite uniform in shape when inhabiting the river systems of the southern and central parts of the United States, and yet show quite distinct changes in form when inhabiting the lake regions of Wisconsin, Michigan and other northern states. Even closely adjoining lakes may contain different varieties or a single lake may contain two of these varieties. Many of these have been caused by isolation in the same manner that land forms have evolved when isolated on island habitats in the ocean. For the purpose of adequate interpretation of these ecological conditions the varieties must receive names even though not all the variations are of equal value. A quadrinomial system might help in some instances, but it is not necessary. Ortmann some years ago propounded a law of river development for the naiades, based on the variation in form of the shell from the headwaters of a river to its lower, larger portion. This law was applied by the writer to the river fauna of Wisconsin and Illinois and found to hold good for nearly all species of naiades. Now to study intelligently these variations coincident with size of a stream it is necessary to have definite trinomial designations for the chief variations which may be characteristic of certain portions of the river, even though these variations are connected by intermediate forms (if they were not so connected they would constitute species).

It appears difficult for many students of nature to realize that evolution is still in progress. Species, while normally reasonably fixed for a limited period, may undergo sudden and marked change when subjected to changes of environment, even when such a simple thing as a log dam is placed across a river, converting it into a pond or lake. The log dam is quite as effective as a glacial dam across a stream which forms a glacial lake, and we have abundant evidence that changes following the damming of streams in glacial times have been followed by the most diverse changes in species, especially in the glaciated areas of Wisconsin and Michigan. There is no such thing in an organic species as the stability that we find in a "title deed," nor can a species remain as fixed as "an authoritative pronouncement from the bench" (which, by the way, may be overruled by a higher court). All animal life is subject to change as soon as the normal conditions of the environment change, and there is evidence that this change may not always be a matter of long years but may take

[4] Baker, "The Fresh-water Mollusca of Wisconsin," Bull. 70, Wis. Geol. Nat. Hist. Survey, 1928.
[5] Goodrich, *Nautilus*, 42: 114–118, 1929.

place in the space of five or ten years. This statement is abundantly supported by experimental evidence. The necessity for giving names to these incipient species is, therefore, obvious.

Taxonomy is but a tool which is used for the interpretation of life processes, and yet its value is beyond question and can not be denied by any one. It is the foundation upon which all the biological sciences rest. The alleged overmultiplication of generic and varietal names is but an attempt to inquire more closely into the true relationships of organisms. More attention should be given to this subject in university curricula in order that the student may have a just appreciation of its importance and an understanding and sympathetic attitude toward the systematist who is endeavoring to make a just and true interpretation of the relation of life to the laws through which it has come into existence. This can not be accomplished by the kind of criticism which has been in vogue, but by an increase of workers who will help to untangle much of the chaos that now surrounds the classification of many groups of animals.

FRANK COLLINS BAKER
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EGYPTIAN MATHEMATICS

IT may be well to make generally available information supplementing, or correcting, some matters referred to in my address on "Mathematics before the Greeks" recently published in SCIENCE,[1] since the matters in question are of somewhat general interest.

(1) Following other writers I referred to the hieroglyph for 1,000 as "a lotus flower" when further investigation would have shown that I should have said "a stem with a lotus leaf."

(2) In giving references to discussions as to "whether the Egyptian had a conception of the general fraction" I might very appropriately have given a reference to a recent discussion by Kurt Vogel who concludes[2]: "Es wird also jetzt von allen Seiten anerkannt, dass der Ägypter den klaren Begriff des allgemeinen Bruches (in dem nicht-komplexen Sinn) gehabt hat."

(3) Quoting Breasted's "Ancient Times," 1916, I noted that "the earliest dated event in history was the establishment in 4241 B. C. of the Egyptian calendar of twelve months of thirty days plus five feast days." Breasted's statement is doubtless based on Eduard Meyer's "Aegyptische Chronologie."[3] In 1917 Borchardt showed[4] that the date 4241 should be 4236 (with a possible error of two years), and up to 1925 this was the accepted date.[5] Mr. S. R. K. Glanville, of the British Museum staff, has, however, kindly pointed out to me that in a recent study of this question, Alexander Scharff[6] makes clear the possibility that 2776 instead of 4236 might in fact be the year when the Egyptian calendar was inaugurated.

(4) One of my statements concerning the Cheops pyramid needs to be revised as follows: "It is said that 100,000 workmen were kept constantly employed on this structure for thirty [not *fifty*] years, ten years of this period being used in constructing a road to the Nile, 1,017 yards [not *limestone quarry some miles*] distant." In the history of Herodotus, written in the fifth century B. C., there is a passage which informs us in this connection as follows[7]:

> Till the time of Rhampsinitus Egypt (so the priests told me) was in all ways well governed and greatly prospered, but Cheops, who was the next king, brought the people to utter misery. For first he shut up all the temples, so that none could sacrifice there; and next, he compelled all the Egyptians to work for him, appointing to some to drag stones from the quarries in the Arabian mountains to the Nile: and the stones being carried across the river in boats, others were charged to receive and drag them to the mountains called Libyan. They worked in gangs of a hundred thousand men, each gang for three months. For ten years the peoples were afflicted in making the road whereon the stones were dragged, the making of which road was to my thinking a task but a little lighter than the building of the [great] pyramid, for the road is five furlongs long and ten fathoms broad, and raised at its highest to a height of eight fathoms, and it is all of stone polished and carven with figures. The ten years aforesaid went to the making of this road and of the underground chambers on the hill whereon the pyramids stand; these the king meant to be burial-places for himself, and encompassed them with water, bringing in a channel from the Nile. The pyramid itself was twenty years in the making. Its base is square, each side eight hundred feet long, and its height is the same; the whole is of stone polished and most exactly fitted; there is no block of less than thirty feet in length.

R. C. ARCHIBALD
BROWN UNIVERSITY
May 10, 1930

[1] SCIENCE, 71: 109, January 31, 1930.

[2] K. Vogel, "Die Grundlagen der ägyptischen Arithmetik in ihrem Zusammenhang mit der 2: n-Tabelle des Papyrus Rhind" (dissertation), Munich, 1929, p. 185.

[3] *Phil. u. hist. Abhandlungen d. k. preuss. Akad. d. Wiss.*, 1904, no. 1, pp. 38–44; French translation by A. Moret, Paris, 1912, pp. 48–55.

[4] L. Borchardt, "Die Annalen und die zeitliche Festlegung des alten Reiches der ägyptischen Geschichte," Berlin, 1917, p. 58.

[5] E. Meyer, "Die ältere Chronologie Babyloniens, Assyriens und Ägyptens," Stuttgart, 1925, p. 45.

[6] A. Scharff, "Grundzüge der ägyptischen Vorgeschichte," Leipzig, 1927, pp. 54–57.

[7] Herodotus with an English translation by A. D. Godley (Loeb Classical Library), London, vol. 2, 1921, pp. 424–427.

CHOMATOLOGY, SOIL SCIENCE

As one brought up in Greece and educated there as far as the baccalaureate degree, I have been especially interested in the recent discussion of the term "pedology" as applied to soil science. The contributions of Shaw,[1] Weir[2] and Peter[3] have shown quite adequately the ambiguity which now exists in the meaning of this term. If it were the most appropriate and precise term, there might be a reason for making some special effort to get it away from medicine and establish its use to designate soil science. As a matter of fact it does not really convey the meaning of soil science as that term is now used.

Whatever might be said in defense of a very general term to embrace the study of soils with no reference to their fundamental significance in plant life, the fact remains that the soil scientists are primarily those interested in plant relations, especially in agriculture. To be sure, the geologist has some interest in soil as the final degradation product of rocks, or as the progenitor of sediments. The engineer is concerned with earth as the material of embankments, dams, excavations and the like. But when we speak of soil science we but rarely and incidentally have these matters in mind. Soil science is a much more precise term than that and means the science of the soil as it relates to organisms living therein, and predominantly as it concerns agriculture. It would seem wholly desirable that any term with the λόγος ending should convey this precise shade of meaning.

Pedology, agrology and humology are all terms which do not describe what we have in mind when we say soil science. Ἔδαφος, the root for the suggested edaphology, is a collective term for ground including soil, and edaphology is fairly appropriate. Choology might serve, since its root word χοῦς means earth or soil. It is the word used in that passage in Genesis descriptive of the creation of man to denote the substance from which man was made; the King James's version translates this word as dust. The most appropriate Greek word is χῶμα, genitive χώματος. Both in classical and modern Greek this word signifies soil as the botanist and agriculturist use the term. Chomatology, therefore, is the most significant term we could adopt.

It has the advantages of being free from any entanglements and ambiguity, easy to pronounce and precise in its meaning.

C. P. Sideris

Association of Hawaiian Pineapple Canners,
University of Hawaii

SPECIAL CORRESPONDENCE

NOTES FROM THE NATIONAL MUSEUM OF CANADA

Dr. R. M. Anderson, chief of division of biology, has received notification of his election as an honorary member of the Ornithological Society of Dresden.

Dr. M. O. Malte, chief botanist, National Herbarium, will attend the International Botanical Congress at London, in July, 1930, and also visit botanical institutions and friends in Sweden, Denmark and other countries.

Mr. P. A. Taverner, ornithologist, left the middle of May for the terminus of the Hudson Bay Railway, at Churchill, Manitoba, and will spend the summer in ornithological work on the west side of Hudson Bay with two assistants.

Dr. Morten P. Porsild, director of the Danish Arctic Station at Godhavn, Disko, Greenland, for many years, is spending several months in Ottawa, assisting in the determination of 15,000 to 20,000 sheets of botanical specimens collected by his sons, A. E. and R. T. Porsild, while on reindeer investigations for the Northwest Territories and Yukon Branch, Department of the Interior, Ottawa, in Alaska and Mackenzie district, Canada, in 1925–28, and by A. E. Porsild in James Bay and Hudson Bay in 1929. The specimens will be retained in the National Herbarium. Dr. Porsild will return to Godhavn on the S. S. *Beothic*, which will visit the Eastern Arctic on its annual patrol, sailing from North Sydney, N. S., late in July.

Mr. Hamilton M. Laing, of Comox, and Mr. Ian McTaggart-Cowan, of North Vancouver, B. C., collected small mammals and birds in the Tobacco Plains region of southeastern British Columbia in April and May for the museum. Mr. Laing began work as park naturalist in National Parks of Canada on June 1, and will be stationed at Jasper Park and Rocky Mountains Park at Banff, Alberta, for the remainder of the season. Mr. McTaggart-Cowan will continue work for the National Museum of Canada until September 30.

Mr. J. Dewey Soper, of Ottawa, who spent 1924–26 as naturalist for the museum in the Cumberland

[1] Chas. F. Shaw, Is "Pedology" Soil Science? *Jour. Amer. Soc. Agron.*, 22: 235–238, 1930.

[2] W. W. Weir, "Soil Science," Science, 71: 218, 1930.

[3] A. M. Peter, "Soil Science," Science, 71: 218, 1930.

Sound region of Baffin Island, and 1928–29 in Cape Dorset and Foxe Channel region for the Department of the Interior, will leave in July for Lake Harbour, Baffin Land, north side of Hudson Strait, where he will spend two years as investigator, North West Territories and Yukon Branch, Department of the Interior. One of the results of Mr. Soper's 1928–29 expedition was the discovery of the hitherto unknown nesting grounds of the blue goose.

CORRESPONDENT

QUOTATIONS

THE DETROIT SESSION OF THE AMERICAN MEDICAL ASSOCIATION

THE multitude of provisions for instruction and entertainment at the Detroit session was perhaps the most striking feature of the annual session of the association just held in that city. Some activity was scheduled for satisfactory use of every moment of the visitor's time, and it remained only for him to employ his time to his own best advantage. From the first two days, during which a series of extraordinary clinical lectures and talking motion pictures were available, to the last three days, in which the fifteen scientific sections provided more than three hundred manuscripts on various phases of medical progress, scientific discourse occupied the auditorium and the halls in the Masonic Temple. At the same time, the greatest number of scientific and technical exhibits ever assembled under the auspices of the association held forth in every available space on several floors in the same building. For the evening the Michigan State Medical Society provided a past-presidents' dinner for the opening night, given exclusively for the officers and the House of Delegates; the opening meeting with the presentation of emblems to past-presidents took place on Tuesday night; numerous fraternity and other social entertainments were held on Wednesday; the president's reception on Thursday, and boat rides, motor bus trips and private tours were provided by the Local Committee on Arrangements for the intervening periods, if any. Obviously, complete utilization of such provisions placed a tax on the physical endurance of the convention guest, and a course of rest and physical training in anticipation of the session was almost necessary to enable the too enthusiastic conventionist to survive successfully the session's attractions. The meetings of the House of Delegates were marked primarily by the demonstration of confidence in the work of the Board of Trustees and by special interest in the economic problems affecting the progress of medicine to-day. Thus, resolutions concerning the care of veterans' legislation, federal aid on maternal welfare, mental hygiene, and similar problems dominated the picture. It is significant that the resolution concerning aid for veterans adopted by the House of Delegates was specifically referred to by the President of the United States in his message vetoing the veterans' bill. The attendance of more than five thousand physicians in a time of financial stress indicates the manner in which the medical profession accepts the importance of this annual session. The appreciation of all of those who attended must be tendered to the Local Committee on Arrangements, which contributed freely of its funds, its time and its efforts to build the success of the meeting. The hospitality shown has established the profession of Detroit in the affections of the Fellows of the American Medical Association.—*Journal of the American Medical Association.*

SOCIETIES AND MEETINGS

THE HISTORY OF SCIENCE SOCIETY MEETING IN DURHAM, NORTH CAROLINA

THE History of Science Society met concurrently with the American Historical Association at the forty-fourth annual meeting at Durham and Chapel Hill, North Carolina, on December 30 and 31, 1929, and January 1, 1930.

This is the tenth anniversary of the History of Science group of the American Historical Association which was inaugurated in 1920 by Dr. Lynn Thorndike, of Columbia University, president of the History of Science Society. The following year a similar section was instituted by the American Association for the Advancement of Science at the Chicago meeting with the late Dr. William A. Locy as chairman of the committee, later vice-president of Section L.

The interest in the history of science movement has grown so steadily ever since that finally both groups were combined to form the History of Science Society, under the direction of Dr. David Eugene Smith at Columbia University in 1924. The society now enjoys its sixth anniversary, and a membership close to seven hundred, consisting of many of the most distinguished scholars and scientists of the world.

The short program presented at Durham on January 1 was entirely devoted to the history of early

American scientific development. Following are the titles of the papers. This meeting was presided over by Dr. Thorndike, and the discussion was led by Dr. L. C. Karpinski followed by Dr. W. H. Welch, Dr. Joseph Mayer, Dr. Victor H. Paltsits and others. Discussion proved of great value and importance.

"Influence of the Mathematics of the French Revolution on Mathematics in American Colleges," by Dr. Lao G. Simons, Hunter College.

"Popularization of Science in the American Revolutionary Era," by Dr. Evarts B. Greene, Columbia University.

"A Century of American Geodesy," by Dr. Florian Cajori, University of California.

"Medical Practice in the Old South," by Dr. Richard H. Shryock, Duke University.

Dr. Shryock's paper was given at 12:30 at the complimentary luncheon (by Duke University) conference on the history of science. Dr. H. W. Tyler, of the Massachusetts Institute of Technology, presided.

Following is an extract of the council record.

The Council of the History of Science Society met at the Hope Valley Country Club, Durham, North Carolina, on December 30, 1929, at 4:15 P. M., with President Lynn Thorndike in the chair. There were present the president, Professors Crew, Cajori, Karpinski, Shryock, Simons, Tyler, Welch and Secretaries Brasch and Mayer. Dr. d'Irsay was also present as a guest. The minutes of the last meeting were read and approved.

The following new officers and council members were elected: *President*, Dr. Henry Crew; *vice-presidents*, Dr. William H. Welch, Dr. Berthold Laufer; *members of the council to serve until December, 1932:* Dr. Victor Robinson, Dr. Henry G. Gale, Dr. Richard H. Shryock, Mr. George E. Roberts, Dr. Alfred C. Lane.

The report of the treasurer and corresponding secretary was read and approved. Mr. Brasch gave an account of his efforts to secure a translation of the work of Copernicus and the nominal expenses involved. The report was accepted and placed on file. It was voted to extend the thanks of the council to the Carnegie Corporation of New York for the appropriation of $7,500 to establish a revolving fund for publications; to authorize the incoming president to appoint a committee of three to be known as the revolving book fund committee to have general responsibility for the administration of the fund, major matters of policy to be passed upon by the council. It was further voted that, if a translation of the Copernicus manuscript entitled "De Revolutionibus, etc.," is published under the auspices of the History of Science Society, it should be a complete rendition of the original.

In the absence of the editor of *Isis*, the president read two communications from him, after which the following actions were taken: Voted that the council authorize the appointment by the president of an executive committee of five members, the incoming president to be the chairman for the year 1930 and to select the other four members;[1] that the executive committee take up with Dr. Sarton the question of drafting an agreement between him and the History of Science Society regarding the conduct of *Isis*.

President Thorndike presented an interesting account of his contact with the Comité Internationale d'Histoire des Sciences in London, after which it was voted to give consent to the use of the name of the History of Science Society in connection with the International Congress of the History of Science and Technology to be held in London in July, 1931, without involving the History of Science Society in any expense.

Dr. Mayer reported informally regarding the work of the endowment committee and read extracts of letters commenting on the tentative draft of the endowment project previously circulated to the council. The report of progress was accepted and placed on file.

Dr. Thorndike was elected delegate to the American Council of Learned Societies for term of four years.

Mr. Brasch was reelected treasurer and corresponding secretary for 1930.

Dr. Mayer was reelected recording secretary for 1930.

It was voted that the executive committee be asked to take up the question of a redistribution of the functions of the treasurer and the secretaries and report back to the council.

The meeting was adjourned at 6:30 P. M.

After the large amount of important matters of business and election of officers, the members of the council enjoyed a unique and fine Southern dinner prepared under the direction of Dr. Shryock. Following this, the members of the council were taken back to hear President James H. Robinson's address.

The History of Science Society will meet with the American Association for the Advancement of Science in Cleveland in 1930.

FREDERICK E. BRASCH,
Corresponding Secretary
JOSEPH MAYER,
Recording Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MICROSCOPE-CENTRIFUGE

THE centrifuge has been used in experimental study of living cells for several types of investigation. First, to determine relative specific gravity and total volume of granules (which are stratified under centrifugal force) present in living cells. Second, to

[1] At a later date the president reported the following appointments to the executive committee: R. C. Archibald, F. Cajori, H. G. Gale, H. W. Tyler, H. Crew.

observe the behavior of mitotic figures and other structures under centrifugal force, experiments which give a clue to the nature of the structure, that is, whether solid and resistant to deformation or merely the configuration of particles in an electrical field. Third, to measure the viscosity of the protoplasm, by applying Stoke's law to the rate of movement of granules under the centrifugal force. The previous procedure has been to centrifuge the cell in capillary tubes, remove it from the tube and observe it under a microscope to determine what happens.

It would obviously be far better to observe the effect of centrifugal force while the force was acting. An instrument for this purpose could be constructed, in theory, making use of several different principles. Our communication describes a practical means of attaining this end. We can obtain a magnified *image* of cells making 2,000 to 3,000 R.P.M. at a distance of 10 cm from the centrifuge axis.

As shown in the accompanying diagram, Fig. 1,

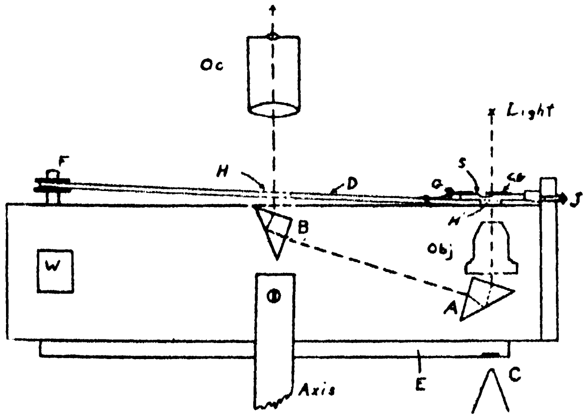

FIG. 1. Optical system of microscope-centrifuge. Explanation in text.

a microscope objective (*obj.*) is built into one end of a bar of metal which is mounted as a head on the centrifuge axis. The objective is purposely reversed from the ordinary position on a microscope so that the light (*L*), the focusing screw (*F*) and the slide containing living cells (*S*) will be easily accessible on the top of the centrifuge. After passing the objective, the light is carried by two total reflecting prisms, *A* and *B*, to the axis of the centrifuge and then vertically upward. The eyepiece (*Oc.*) is stationary and mounted permanently above the axis of the centrifuge. The counter weight (*W*) is used for balancing.

A slide to hold cells can easily be made from a hollow depression microscope slide by cementing a cover slip (*C.G.*) over one half of the depression. There is thus formed a niche between cover slip and surface of slide in which cells are thrown by the centrifugal force. The slide, cut to proper size, is laid on a flat strip of metal, *D*, with holes at *H* and *H'* for passage of light, and held down by the clamp *G*. Its position in the direction of the centrifugal force can be adjusted by the screw *J*. The slide can be focused by moving the whole bar, *D*, up and down on the focus screw *F*, and additional focusing during centrifuging is obtained by changing the vertical position of the ocular. If the cells are illuminated continuously, the image in the eyepiece, while the centrifuge is running, would be whirling in a small circle. However, if we illuminate the cells for a few microseconds every time they reach a position in the revolution under the light, the appearance will be that of a succession of images, a moving picture. The cells will appear stationary; the granules within will be seen to move under the centrifugal force.

The illumination is a 2,000 volt condenser discharge in mercury vapor at atmospheric pressure or above. The lamps can easily be made by sealing a tungsten wire into one end of a pyrex capillary tube which is partly filled with mercury. A portion of the tube near the other end of the capillary is enlarged to a small bulb and an iron wire pushed down the capillary to the proper distance from the tungsten to form the other electrode for the condenser discharge. This iron electrode is then sealed in with deKhotinsky cement, leaving the bulb filled with air. A heating coil around the capillary, not shown in the illustration, protected from air currents by an enclosing pyrex tube, boils the mercury in the capillary, forming mercury vapor through which the discharge takes place. A reservoir condenser is kept continually charged to 2,000 volts from a transformer and rectifying tube. The discharging condenser, of lower capacity, is in parallel with the reservoir condenser through a high resistance. With each revolution of the centrifuge the contact point *C* on the bakelite disk (*E*) discharges the 2,000 volts through the mercury lamp, and during the remainder of the revolution the condenser is again charged through the

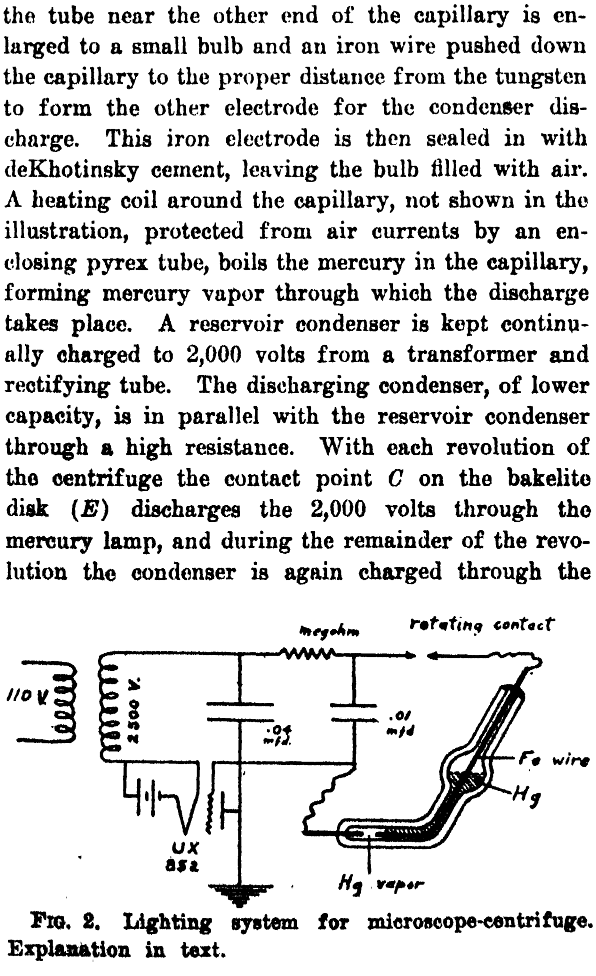

FIG. 2. Lighting system for microscope-centrifuge. Explanation in text.

high resistance and is ready for another discharge. The wiring diagram and lamp are shown in Fig. 2.

The image is remarkably steady with high power objectives (×62) and we have obtained photomicrographs with the microscope-centrifuge, using a ×62 objective, of bacteria and chromosomes in dividing cells which can hardly be distinguished from those taken when the cells are at rest.

E. Newton Harvey
Alfred L. Loomis
Princeton University
Loomis Laboratory,
Tuxedo Park, N. Y.

SPECIAL ARTICLES

OBSERVATIONS ON THE GROWTH OF CHILDREN

A clear understanding of the statistics of growth can not be obtained through a study of single measurements taken on masses of children of the same age—by the so-called generalizing method, but requires the study of individual amounts of growth. If the generalized series is considered as representative of individual growth, two assumptions are made; the one that the traits of the population represented by children of different ages remain the same from year to year; the other that all children pass through the period of growth at the same rate. Neither of these assumptions is admissible. Observations in Europe show clearly that the size of the body is undergoing secular changes. From the middle of the past century until the beginning of the present century the average stature in Europe increased in every single country. Recent observations also show that the stature of growing children, comparing the years 1880 and 1921, has considerably increased.[1] Besides these increments, which are probably due to better control of diseases of childhood, perhaps also to general improvement in hygienic conditions, there are minor changes which occur from year to year. I have studied the statures of individuals born during the period from 1870 to 1916 from this point of view. When the general variability of stature is known and the number of individuals of each year is given, it is possible to determine statistically what the variability of average statures from year to year would be if there were only accidental causes at work bringing about variations. As a matter of fact, the variability from year to year is on the whole too large and the calculation shows that a standard variation of about 0.5 cm or more must be assumed for irregular variations of stature. This variability of stature, so far as it is not due to chance, has been calculated from observations of children born in various years. It will be understood that the numbers of cases are observations repeated annually, many taken on the same individuals, not all distinct individuals.

Hebrew Orphan Asylum, N. Y.	2,275 boys	(born between 1894 and 1916)	$\Sigma = \pm$ .51 cm
" " " "	2,178 girls	(" " 1889 " 1916)	$\pm$ .45 cm
Ethical Culture School, N. Y.	1,248 boys	(" " 1889 " 1916)	$\pm$ .49 cm
" " " "	1,154 girls	(" " 1891 " 1915)	$\pm$ .53 cm
Newark Academy	3,817 boys	(" " 1870 " 1898)	$\pm$ 1.13 cm

The available material is not sufficient to allow us to determine whether there are any cycles of these changes, or what the actual differences of stature from year to year are. We may, however, be certain that variations do exist.

It seems likely that these changes will not influence the course of individual development materially. Much more important is the uneven rapidity with which children pass through the period of development. I have pointed out before[2] that the variability of physiological age increases very rapidly during life. At the time of birth it may be measured by a few days. That is to say, the total period of gestation differs only by a small number of days. The eruption of the first teeth differs by several weeks. The time of eruption of later teeth is even more variable. The time of reaching maturity varies by more than a year and that of senescence by seven or eight years. While it is not admissible to assume that the variability of any one of these phenomena indicates a general variability in physiological age of the whole organism, all the data combined show that the variability of physiological status increases rapidly during the course of life.

The curve of growth for the body as a whole, as

[1] Robert Rössle and Herta Böning, "Das Wachstum der Schulkinder," *Veröffentlichungen aus der Kriegs- und Konstitutionspathologie*, Vierter Band, Heft 1, pp. 24 et seq.

[2] Franz Boas and Clark Wissler, "Statistics of Growth" (Report of the U. S. Commissioner of Education for 1904), Washington, 1905, p. 40.

well as for its parts, is characterized by a gradual decrease in the rate of growth during childhood, followed by a period of increased rapidity of growth during adolescence and final completion of growth when maturity is reached. I demonstrated a number of years ago that, admitting the variability of physiological development and its determinant influence upon growth rates, the actual individual growth rate must show a much more decided decline during childhood and a much more decided increase during adolescence, and that at the same time the period of increased rapidity of growth during adolescence must be much shorter than would appear from the generalized curve.[3]

A number of years ago I obtained, through the courtesy of Dr. Wilson Farrand, continuous measurements of boys in the Newark Academy, a rather uniform social group of almost exclusively northwest European descent. These data were calculated according to my suggestion by the method of correlation by Dr. Clark Wissler.[4] It appeared later that this method is unsatisfactory on account of the asymmetry of the growth curves and because the fundamental questions are not well expressed by the coefficient of correlation. Furthermore, the data did not continue until the adult stage was reached. For this reason I have treated the same material according to another method. I also obtained with the kindly help of Dr. Farrand the adult statures of a fairly large number of the former students of the academy.

In Fig. 1 are given the total increments of stature up to adult stature for each year, beginning with 11 years. The ordinates show the total amount of growth from 11, 12 . . . up to 17 years on to adult stature. The abscissae show the statures at the initial age. The curves have been calculated from the data as parabolas, which seem to render the data adequately. It will be noticed that in early years the maximum total increment does not belong to the shortest individuals. The curves have a maximum and later on drop off very rapidly. From 11 to 15 years the curves are decreasingly concave; from 16 years on, convex. On the curves are indicated the average statures for initial years, the points at which the increment up to adult stature is a maximum and the point for

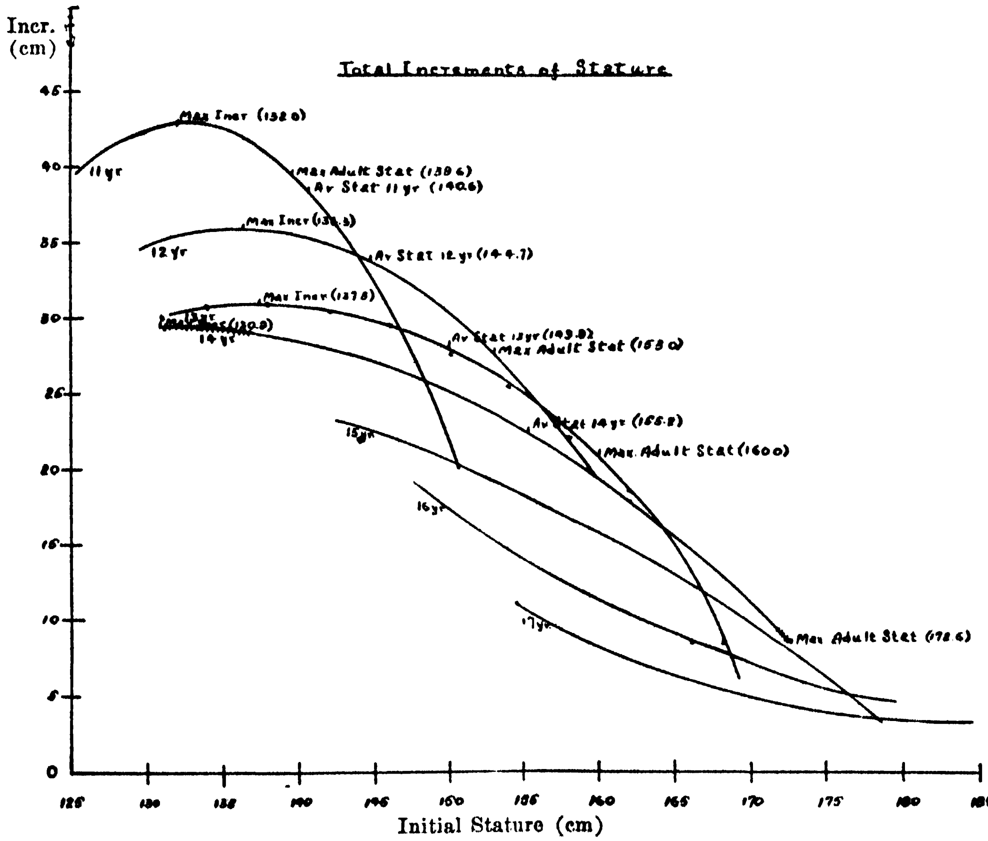

FIG. 1

[3] *Ibid.*, pp. 42, 48.

[4] *Ibid.*, pp. 43–45; *Amer. Anthropol.*, N. S., 5: 81–88, 1903.

which the adult stature is a maximum. For 11 years the maximum increment is found for children 132 cm tall, the average stature is 140.6 cm, the maximum adult stature belongs to those who have at 11 the stature 139.6 cm.

The general curve of growth of children 12 years old of various initial statures is illustrated in Fig. 2. In this figure the abscissae represent statures at 12 years, the ordinates the growth up to 13, 14, etc., years. In Fig. 3 the annual increments for 14 year

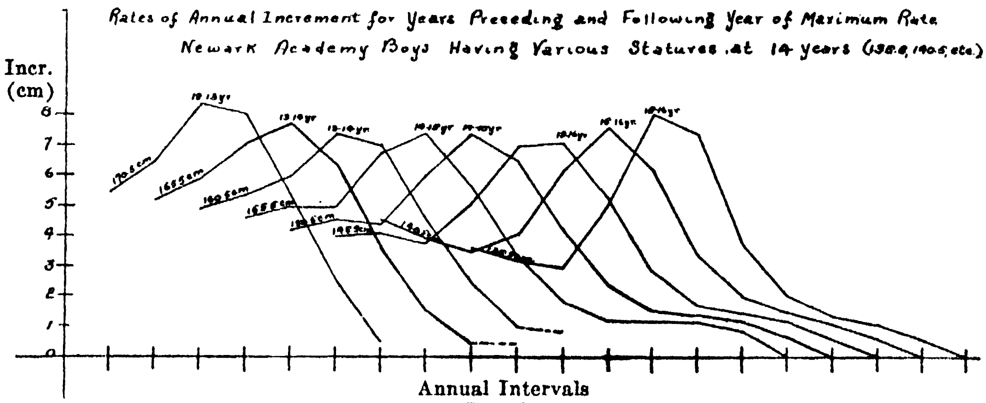

FIG. 3

old boys obtained from these parabolic curves have been so plotted that the maxima are placed side by side. Each curve contains individuals in a group of 5 cm—to the left the tallest (167.5–172.5), to the right the shortest (132.5–137.5). The absolute age to which each curve belongs may be determined from the year indicated at the point of maximum annual rate. It will be noticed that among the shortest children the pre-adolescent decrease in the rate of growth continues. It appears also that the maximum rate decreases with decreasing initial stature except for the two shortest groups. I have calculated from these data the time of maximum rate of annual growth for boys of various initial statures at 12, 13 and 14 years.

The following table gives the data.

FOR BOYS OF AGE	11.5	12.5	13.5	14.5
Average stature	140.5	144.7	149.9	155.2
Maximum increment for initial stature at	132.0	136.3	137.5	——
Maximum adult stature for initial stature at	139.6	153.0	160.0	172.6

These values must be considered as approximations, subject to revision when fuller material is available.

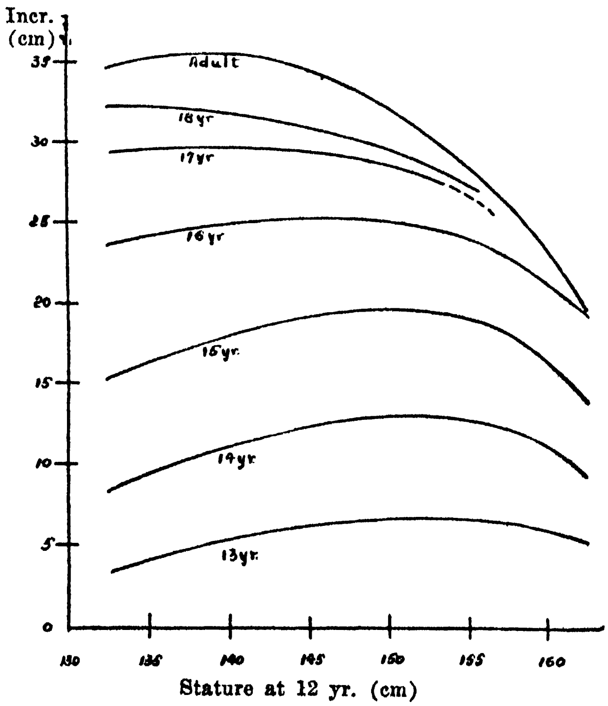

FIG. 2

MAXIMUM RATE OF GROWTH FOR BOYS OF VARIOUS AGES

	Years	Years	Years
Statures	12.5	13.5	14.5
	Maximum Rate at		
132.5	15.8	15.3	16.7
137.5	15.2	14.8	16.0
142.5	14.7	14.7	15.5
147.5	14.3	13.7	14.8
152.5	(12.5)	13.7	14.3
157.5	—	13.2	14.0
162.5	—	11.6	13.4
167.5	—	—	13.1

For the average statures this would give[5]:

[5] The differences between the following averages and those given before are due to the inclusion of additional individuals in the present series.

Age years	Average stature	Age of maximum rate
12.5	145.2	14.5
13.5	149.9	13.7
14.5	155.5	14.1,

approximately the same age. The table shows clearly the acceleration of development with increasing initial stature.

These phenomena may also be approached by a study of the growth of individuals who have their maximum growth at the same period. For the boys of the Newark Academy the average age at which the maximum rate of growth occurs is 14.5 ± .9 years.

Fig. 4 indicates the course of actual growth of five groups. The first has its maximum rate of growth between 12 and 13; the second from 13 to 14, and so on up to those in which the maximum growth rate is between 16 and 17 years. It will be seen that the statures of those who have the earliest maximum growth are considerably larger than those of others who have the maximum growth at a later time. The differences naturally increase first, but decrease again considerably later on. The differences among the adults of these various groups are so small and so irregular that, considering the small number of cases that are available, we may well assume that there is no relation between the time when the greatest rapidity of growth sets in and the stature finally

STATURES AND VARIABILITIES OF NEWARK BOYS WHO HAVE THEIR MAXIMUM RATE OF GROWTH IN VARIOUS YEARS (IN CM)

Age	Maximum rate at					Total
	12–13	13–14	14–15	15–16	16–17	
11	142.2 ± 5.1	140.5 ± 5.4	139.5 ± 5.4	135.8 ± 5.4	———	139.7 ± 5.7
12	148.7 ± 5.5	145.5 ± 5.3	143.9 ± 6.3	140.8 ± 6.4	———	144.3 ± 6.3
13	158.7 ± *6.5*	151.8 ± 5.2	148.6 ± 6.7	144.7 ± 6.3	———	149.4 ± 7.2
14	165.7 ± 6.4	161.1 ± 5.5	155.1 ± 6.9	150.2 ± 6.8	145.7 ± 7.3	155.7 ± 8.3
15	170.2 ± 5.9	167.2 ± 5.5	164.1 ± *7.0*	156.3 ± 7.2	150.5 ± 7.4	162.8 ± *8.4*
16	———	170.9 ± 5.7	169.9 ± 6.9	165.1 ± *7.3*	157.2 ± 7.5	168.1 ± 7.7
17	———	172.8 ± 5.0	172.6 ± 6.8	170.0 ± 7.0	165.9 ± *8.1*	171.2 ± 7.0
18	———	———	174.5 ± 6.8	173.3 ± 7.6	169.0 ± 7.9	173.6 ± 6.7
Adult	(175.7)	174.2 ± 4.6	176.7 ± 5.6	178.9 ± 6.3	(175.4)	176.1 ± 5.9

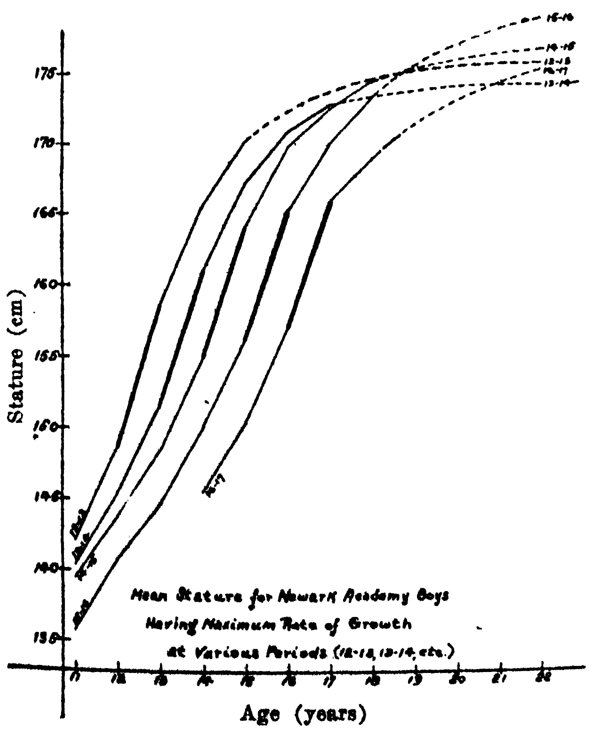

FIG. 4

attained. This conclusion is subject to revision when more material will be available. The averages and various totals for this series are given in the table given above.

It will be remembered that during the period of acceleration of growth the variability of the whole series increases considerably and decreases again later on. I have pointed out at a previous time[6] that this can best be explained as an effect of the difference in period when the greatest acceleration of growth occurs. It is interesting to note that the variabilities of the five curves, just shown, still indicate an increase in variability at the time of most rapid growth. The amount of this variability is considerably less than in the entire series. For boys who have their maximum rate of growth between 13 and 14 years there is practically no change in the variability from 11 years to 17 years. It is quite striking that the variabilities are the greater the later the period of most rapid growth. In our present series the variability of the adult is also the greater the later the period of most rapid growth. It remains to be seen whether this is a significant differ-

[6] "Statistics of Growth," p. 25 et seq.

ence. If it is, we might conclude that environmental conditions have the more effect the longer they exert their influence upon the body.

An analysis of the data also shows that the earlier the most rapid growth occurs, the more intensive is the total amount of increment during the period around the maximum rate. This is indicated in the following table.

Increments of Stature of Newark Boys During Intervals Around Year of Maximum Rate of Growth

	Intervals in Years			
Maximum rate	− 0.5 to + 0.5	− 1.5 to + 1.5	− 2.5 to + 2.5	− 3.5 to + 3.5
Years	cm	cm	cm	cm
12–13	10.0	23.2	32.2	38.0
13–14	9.2	21.7	30.1	37.0
14–15	9.1	21.5	29.3	35.4
15–16	8.8	20.4	27.8	33.3
16–17	8.7	20.0	27.9	34.5

The intensity of growth during the period of adolescence is the less the later adolescence begins.

The distribution of individual increments in each of these groups is not by any means uniform. To a certain extent this is due to the grouping together of an interval of a whole year, for during this period considerable changes in rate of growth occur. Furthermore, the differences between measurements taken at annual intervals from which growth rates are obtained are always inaccurate, so that their variabilities contain a rather large element due to observational errors. More important, however, are the individual differences in periods of acceleration and of total growth. This is indicated in the following table.

Percentage of Those who Grow Less than 1 cm from Various Ages on, According to the Period of Maximum Rate of Growth

Maximum rate	Age after which growth is less than 1 cm			
	16 yrs.	17 yrs.	18 yrs.	19 yrs. or more
	Per cent.	Per cent.	Per cent.	Per cent.
13–14	5	25	28	42
14–15	1	5	19	75
15–16	0	0	9	91

The distribution of amounts of annual increments for the group with maximum growth between 14 and 15 years is shown in the following table.

Individual Increments for Newark Boys with Maximum Rate of Growth between 14 and 15 Years

cm	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18
0– 0.9	—	—	1	1	—	1	5	11
1– 1.9	—	1	—	1	—	2	11	14
2– 2.9	—	1	1	—	—	4	25	15
3– 3.9	4	12	17	2	—	6	21	4
4– 4.9	8	27	29	13	—	18	14	—
5– 5.9	7	14	31	22	1	28	2	—
6– 6.9	1	3	11	36	2	34	2	—
7– 7.9	—	—	2	29	15	17	1	—
8– 8.9	—	—	1	16	42	13	—	—
9– 9.9	—	—	—	5	39	1	—	—
10–10.9	—	—	—	1	18	—	—	—
11–11.9	—	—	—	1	7	—	—	—
12–12.9	—	—	—	—	4	—	—	—
13–13.9	—	—	—	—	1	—	—	—

It will be seen that at the time of maximum rate of growth the distribution of increments is quite symmetrical, while at earlier and particularly later periods it becomes very asymmetrical on account of the varying length of the growth period.

These observations may be expressed in a general statement. The life cycle of children between the ages of 10 and 20 years develops with varying rapidity. In some individuals the whole physiological development so far as it is expressed by stature proceeds rapidly and energetically and the whole developmental period is short; in others it is sluggish and occupies a much longer period. The question arises whether this is true for life as a whole. Dr. Pearl has shown that among lower animals there are considerable variations in the life cycles of various lines of the same species, partly dependent upon environment, partly on heredity. Bell's studies of longevity in family lines suggest similar conditions in man. The question arises whether the rapidity with which the individual passes through the stages of early life continues later on, whether the life cycle of rapidly developing individuals is shorter than that of slowly developing ones. I have attempted to find whether a relation exists between the time of first menstruation and menopause. The available material is not satisfactory, but apparently there is no correlation between these two. The solution of the problem requires further and more carefully recorded data than those now available. It will be important to study the rates of the cycle of life in various racial and environmental groups. Available data show a very clear influence of social status upon the rapidity of the life cycle, while the hereditary control is not so clear.

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PROMOTION OF MEDICINE AND PHARMACY[1]

By Professor REID HUNT

HARVARD MEDICAL SCHOOL

ONE of the duties of the president of this convention, as stated in the by-laws, is the presentation of an address "embodying such subjects as may seem to him suitable to the occasion."

Since many of those present are attending a meeting of the convention for the first time, it may be well to speak briefly of the purposes and history of this organization. It was founded in 1820 and has been in continuous existence ever since; the first sessions were held in the Senate Chamber of the Capitol. It is one of the oldest organizations in the United States, antedating by many years the American Medical Association, the American Pharmaceutical Association, the National Academy of Sciences, etc. It was founded by physicians; perhaps it would be more accurate to say that it was founded by a single physician, Lyman Spalding. Spalding was a man of rare vision; he was a pioneer in medical education and sanitation; he had an important part in the introduction of vaccination into the United States. His most important service, however, was the founding of the U. S. Pharmacopoeia, which is the oldest national pharmacopoeia of a modern type in the world. The U. S. P. was the first pharmacopoeia to adopt the recommendations of the Brussels Conference for the Unification of Potent Medicaments; it thus became the first national pharmacopoeia with an international character. It has also been translated into Chinese and Spanish; it is the official pharmacopoeia of Cuba.

This convention, which is incorporated under the laws of the District of Columbia, is different from most associations; the members are not here for any personal gain; all their activities are in the interest of the health of the people of the United States.

[1] Presidential address delivered at the 1930 U. S. Pharmacopoeial Convention, on Tuesday, May 13, in Washington, D. C.

The articles of incorporation state that the objects and business of this association are the promotion of medicine and pharmacy by selecting such materials as may be properly used as medicines and drugs, establishing formulas for their preparation and standards for identity, strength and purity.

Thus, provision for the selection of materials which may properly be used as medicines is the first duty of the convention.

So perhaps our function may be compared to that of those who are behind the lines of combatant troops: to select, standardize, properly label and pass forward the munitions which the actual fighters need. How important is the correct labeling of a drug may be indicated by the fact that one drug (epinephrin) was passed forward under thirty-five different names. The physician is constantly confronted with so many difficult problems that it is unfair both to him and the patient for such additional confusing factors to be introduced.

I think we must admit that those whose lives are spent in constant contact with the sick are in a better position to judge of what is and what is not useful than are those who can get such information only by gossip and hearsay. Hence, it has usually been the custom to place the major portion of the responsibility of determining what medicinal agents shall be admitted to the Pharmacopoeia upon the medical members of the convention, while much of the remainder of the revision work has been carried out by the pharmacists and chemists, who were invited by the physicians to join this organization in 1850.

This general principle was enunciated in 1820 by the founders of the U. S. P. in the following words: "It is the object of a pharmacopoeia to select from among substances which possess medicinal power, those, the utility of which is most fully established and best understood; and to form from them preparations and compositions, in which their powers may be exerted to the greatest advantage." Similar views had been expressed in the Pharmacopoeia of the Massachusetts Medical Society (1808)—the first civilian pharmacopoeia prepared in the United States, and which served as a model for the U. S. Pharmacopoeia. The authors of this work also had decided views as to the responsibilities of the two professions concerned with the preparation of a pharmacopoeia. They stated: "As it is the business of the physician to prescribe and of the apothecary to prepare medicines, the physicians as a body ought to point out those articles of medicine which they shall ordinarily employ, and the standard preparations of them." In later revisions reference was made to the "wants of the medical profession," the undesirability of "pandering to fashion," etc.

These principles were reaffirmed by the last convention when it stated that the object of the Pharmacopoeia is to provide standards for drugs and medicines of therapeutic usefulness or pharmaceutical necessity. In carrying out this program, fifteen subcommittees were elected; eleven of these consisted largely of pharmacists and chemists, whereas in four, medical representatives predominated. In the committee on scope (admissions and deletions) there were sixteen representatives of medicine and five of pharmacy.

This principle of "therapeutic usefulness or pharmaceutical necessity" has prevailed during much of the hundred and ten years of the existence of the Pharmacopoeia, but for a comparatively brief period "used" rather than "usefulness" seems to have governed the admissions. This led an eminent physician, for twenty years president of the convention, to state that there were preparations in the U. S. P. no more active or more useful than brick dust, and that brick dust would go into the Pharmacopoeia if there were a demand for it.

Such a view of the scope of the Pharmacopoeia has not been usual; it is inconsistent with the very purpose of the work as stated in the articles of incorporation; certainly medicine and pharmacy would not be promoted by the inclusion of worthless drugs. Physicians have frequently been thought to be rather indifferent to the Pharmacopoeia and perhaps for two or three decades they were: a physician engaged in a life-and-death struggle does not want his armamentarium cluttered up with brick dust and it has always been and always will be useless to expect his support for a work of that character.

That revision committees recognized the fallacy of basing admissions upon use is shown by the fact that, in the course of three decades, no fewer than 573 articles were dismissed from the U. S. P.; although the suggestions as to the preparations to be omitted originated for the most part with the physicians, the representatives of pharmacy, who outnumbered the physicians two to one, gladly acquiesced.

May not this return to the ideals of the fathers of the Pharmacopoeia be another recognition of how clearly the men of that day saw great general principles? Would not the founders of the Pharmacopoeia have been as surprised at some of the developments in regard to this work as the authors of the Constitution of the United States would have been at some of the amendments which have been added?

There never has been a time when there were not drugs in rather extensive use which were soon forgotten: the authors of the Pharmacopoeia of 1820 evidently had this in mind when they stated that, of the substances which possess medicinal value, only those

the utility of which is best established should be admitted to the Pharmacopoeia.

It would seem easier at present than ever before to adhere to these basic principles. Each of the professions chiefly interested in the Pharmacopoeia now has its own special book of standards into which preparations of more immediate interest to its members may be introduced: the National Formulary and "New and Nonofficial Remedies."

The National Formulary was founded by the American Pharmaceutical Association in 1888. The committee which prepared it stated that "it was not within the province of the committee to meddle with matters of which the medical practitioner is the proper and competent judge," and added that their object was to establish formulas for preparations which were used either by physicians or the laity and which were not in the Pharmacopoeia.

Thus these two works were designed for special purposes: the Pharmacopoeia as a book of standards for the drugs which the physician finds useful in the practice of medicine; the National Formulary as a standard for various preparations not in the Pharmacopoeia, but which the pharmacist is asked to supply. There seems to be little reason for confusing these functions, especially since the National Formulary has the same dignified standing under the national and state drug laws as has the Pharmacopoeia. The pharmaceutical profession also has a recipe book in which still more preparations, in which its members are especially interested, are described.

"New and Nonofficial Remedies," which is published annually, provides standards for drugs which seem to the physician to be promising and which are developed between the revisions of the Pharmacopoeia and the National Formulary.

It should also be recognized that each profession has its own peculiar interests: the need of the surgeon for drugs and supplies, while urgent, is limited to a comparatively few articles with which the pharmacist is directly concerned. Similarly, the modern drugstore has developed to meet a demand for many things in which the physician is not especially interested. May not this fact account partly, but only partly, for the feeling among some pharmacists that the medical profession does not give the support it might to professional pharmacy?

It is somewhat disconcerting, however, to find that a distinguished ex-president of the American Pharmaceutical Association (D. F. Jones), whose ideas of the relation of the professions of medicine and pharmacy to each other are so strikingly like those of the medical profession, has expressed the view that the Pharmacopoeia seems to have grown of less practical value to the professional pharmacist and the practicing physician. I think that it can be shown that, as regards the members of the medical profession, conditions are changing and that they are appreciating more and more the value of the Pharmacopoeia.

One reason why I speak with so much confidence of the interest, at the present time, of the medical profession in the U. S. P. and of their real and practical loyalty to the work, is based upon the little book, "Useful Drugs," issued by the American Medical Association—the largest association of physicians the world has ever known.

The drugs listed in this book, the eighth edition of which is now in preparation, are selected with but a single purpose: the welfare of the sick. There are no restrictions as to their source; the U. S. P., the National Formulary and the whole group of non-official and proprietary remedies can be drawn upon. The list represents the drugs which large numbers of physicians in active practice voted to be of prime importance, and a few vehicles and flavoring agents.

This list of drugs has been accepted by the national and state boards as the basis for examinations for license to practice and by the medical schools as the basis for the teaching of materia medica and therapeutics, and by leading hospitals as representing the most important drugs.

The number of drugs which it seemed necessary to include in this list may surprise many physicians—there are about 365 of them—more drugs than there are bones or muscles in the body; the drugs are more numerous than the diseases which a physician ever sees. The great war was waged with fewer munitions. And yet physicians are criticized for not prescribing more and still more drugs.

All but seventeen of the 365 preparations in "Useful Drugs" are in the present U. S. Pharmacopoeia.

The founders of the Pharmacopoeia stated in 1820: "The value of a pharmacopoeia depends upon the fidelity with which it conforms to the best state of medical knowledge of the day. Its usefulness depends upon the sanction it receives from the medical community and the public."

It may be that the adoption of the Pharmacopoeia as a legal standard, which necessitates the introduction of the most precise methods of analysis, has tended to diminish its usefulness to the practical pharmacist. But we can hardly begrudge this inconvenience when we think of what it means to the welfare of the people of the United States. These high standards also give the discriminating physician as well as the public greatly increased confidence in the U. S. P. drugs.

Possibly the asserted decline in the usefulness of the Pharmacopoeia to the pharmacist is more apparent than real; it may be a matter of dilution. An ob-

server can not but note the number of drug-stores and pharmacists in the United States, as compared with the number in some foreign countries; it is authoritatively stated, for example, that there are approximately 57,000 drug-stores in the United States, one to less than three physicians. In proportion to the population, the United States has six times as many drugstores as has Germany.

The physicians have few professional interests aside from the care of the sick; they outnumber the pharmacists by almost two to one; is it not logical to let them determine what shall be included in the work which they themselves established? Of course, physicians at times have been woefully blind—blind for centuries—to the virtue of a drug, but have their colleagues in other fields seen more clearly? Certainly, in one of the most frequently cited cases of this kind, the physicians saw more clearly than did their critics. A recent writer states, as have earlier writers: "In 1880 a British Medical Commission learnedly reported that cocain had no medical value, being at best merely a poor substitute for caffein." No references are given as to where this commission reported, or who composed it. But, in any case, it seems to be forgotten that the really important use of cocain is as a local anesthetic and that this action was not recognized until 1884. Among the uses proposed for cocain before 1884 were the following: insanity, epilepsy, cachexia, bodily and mental exhaustion, melancholia, neurasthenia, hysteria, etc. It was also proposed to give it to soldiers and sailors to appease hunger and thirst and to relieve fatigue. The thought of cocainized armies and navies is rather appalling—our Army and Navy have had sufficient troubles with individual cases of cocain addiction. May not the "British Medical Commission" (whoever composed it), which is said to have reported adversely on the internal use of cocain, have been rather wise in their day and generation?

An examination of the preparations in "Useful Drugs" also shows that there are not as violent and as radical changes in the physician's use of drugs as many seem to believe. More than half of the preparations in "Useful Drugs" were in the Pharmacopoeia of the Massachusetts Medical Society of 1808. It is almost startling to find so many of the standard remedies of to-day in this 122-year-old book. The salts of iron, mercury, silver, copper, arsenic, antimony and zinc were there, as were also opium, digitalis, cinchona, ipecac, aloe, rhubarb, senna, chenopodium, sulphur and many others. Ordinary ether and the spirit of ether were there, although the most important action of ether—the production of general anesthesia—was not recognized until thirty-eight years later.

Chairman Cook has recently pointed out that, of the 305 individual therapeutical agents in the latest revision of the U. S. P., 114 were official in the U. S. P. of 1820—another illustration of how wisely our earlier predecessors selected the articles for the Pharmacopoeia.

Progress in drug as in other forms of therapeutics often seems very slow, and every one is painfully conscious of the great gaps to be filled. But, looked at from a broader point of view, the progress has been very encouraging. The drugs in the first edition of the U. S. Pharmacopoeia represented the achievements of mankind in this field in all the ages; some of the most important drugs (opium and its preparations, metallic mercury, etc.) were in the pharmacopoeia of Dioscorides of A. D. 77. The additional drugs in the tenth revision represent the advances in a single century.

This convention is the only representative organization in a great country devoted to the scientific consideration of drugs; it is the only place where pharmacists, chemists and physicians come together. Would it not be proper to consider briefly means by which new therapeutic agents may be added to what are already available? Every such addition increases the usefulness of the professions to the public and adds to the standing of both physicians and pharmacists in the community.

I may call your attention again to the wording of our articles of incorporation: the "encouragement and promotion of the science and art of medicine and pharmacy by selecting by research and experiment and other proper methods—such materials as may properly be used as medicine."

What was the source of the medicines in the U. S. Pharmacopoeia at present? How were their medicinal properties discovered? I mentioned how, speaking in very general terms, the drugs of outstanding, universally recognized value—the sort of drugs which led Sydenham to make his famous remark that without opium few would care to be physicians—fall into two groups: those which were available when the first Pharmacopoeia was published and the additional ones to be found in the tenth revision. A physician might hesitate if he were forced to choose between the drugs in the 1820 Pharmacopoeia and the new drugs discovered in the last 110 years. Again speaking in general terms, the drugs of the first period resulted from empiricism, those of the latter period from pharmacological experimentation; the drugs of the former period were for the most part available as such in nature, whereas among those of the latter group there are a large number of synthetic drugs. The plant world will doubtless still yield valuab therapeutic agents; the possibilities of the ani

world are by no means exhausted, but after all there is a limit to what can be expected from these sources. But the field of synthetic organic chemistry has no limits. Already some of our most valuable drugs have come from that field.

Some of the saddest pages in the history of mankind are connected with the failure of physicians to see the therapeutic possibilities in well-known chemicals. Take for example an incident, typical of many, which occurred at the Massachusetts General Hospital about 1821, as described by J. C. Warren: a patient with a dislocation of the hip was given powerful purgatives, a hot bath and then tartar emetic to produce deadly sickness; a vein was opened and blood drawn as rapidly and in as large quantities as possible (the "unholy trinity of bleeding, purging and puking"). Then pulleys were attached to the limbs and power traction exerted for an hour, with occasional intermissions to permit a slight recovery from the pain; but the dislocation was not reduced. A contemporary writer compared the procedure to the execution of a would-be assassin of a king of France: four powerful young horses, attached to the limbs of the criminal, pulled for fifty minutes before the man was torn asunder. Stories are told of how the cords to the pulleys broke and had to be repaired while the patient waited—stories strangely reminiscent of the breaking and repairing of the hangman's rope. The records of successful operations in those days usually closed with the words, "the patient was untied and returned to bed." But these methods were considered by the surgeons of Dr. Warren's time, and earlier, as very humane; Percival Pott remarked in 1779 that the mere relation of the methods used in earlier times was sufficient to shock any humane man. The descriptions of the machines, or, as they were called, "engines" of earlier days strongly suggest that they were transferred from the torture chamber to the clinic; or were they taken from the clinic to the torture chamber? There were stories of thumbs and even arms being torn off by these efficient "engines." Yet patients preferred even this kind of treatment to no treatment.

A drug by the use of which the vomiting and purging and bleeding and the pain in such cases could have been prevented had already been known for nearly three hundred years; Dr. Warren knew it in 1805; he and Dr. Jackson had described its preparation and properties for the Massachusetts Pharmacopoeia of 1808; it was in the first U. S. Pharmacopoeia. For a quarter of a century before the ether day of October 16, 1846, it had been in the very hospital in which Dr. Warren operated; the pharmacist knew it well, for he made it himself and often supplied it to the hospital students for their—politely called—"ether frolics." It was a well-known drug at the time of the American Revolution and during the Napoleonic wars, when a single surgeon sometimes did two hundred amputations in a day. Why this three hundred years' delay? Because the physicians of those days were convinced that they knew enough to state positively that such results as were caused by ether would never be obtained with any drug, and because they had not yet learned to appreciate the value of experiments on animals.

Many analogous scenes could be recalled: patients with lockjaw; blisters produced from ear to ear in the vain effort to secure relaxation of the jaw; teeth broken so that a few drops of water or milk could be given. Or consider the scenes in the tetanus hospital at Gettysburg: sentries removed far from the hospital so that the sound of their footsteps would not throw the inmates into spasms, or the night when a wind arose and rattled the windows and the wounded soldiers passed the night in one painful convulsion after another. Contrast this scene with one in a German military hospital in 1915. Again patients with lockjaw; unable to swallow; excruciatingly painful cramps, intense cyanosis. A small amount of a solution was injected into a vein: in two minutes the convulsions ceased, pain disappeared; the patients were soon eating, drinking, reading, playing cards, laughing. Or consider a scene at the Massachusetts General Hospital: a child in strychnine convulsions; life maintained by artificial respiration. A few drops of a solution injected into the spinal canal: instant recovery; in a few minutes, child interested in toys; no return of the convulsions.

And the drug in these cases was Epsom salt, well known to the medical profession since 1694 and, of course, in all the older Pharmacopoeias. But no one seemed interested until 1905 in determining what this drug would do when injected into an animal or a man.

Just one more such picture: "There was one poor man in the wards suffering dreadfully from angina pectoris; he used to have an attack every night and for two hours the unfortunate man would sit on the edge of his bed and could not move forward, backward, or to one side, with his face pale and sweat pouring off it, in perfect agony." Three or four drops of a drug were inhaled. The impossible happened: "instant and complete relief" in this most painful condition. And the drug, amyl nitrite, had been well known to chemists for twenty-three years.

The same story with acetanilid and similar drugs: relief may be obtained anywhere in the world for a few cents, which fifty years ago was beyond the reach of any potentate or Croesus. The bromides which in 1853 first brought relief to one of the longest

known and most distressing diseases, chloral hydrate, cocain, phenol and many other drugs were well known to chemists long before they were to physicians. Arsphenamine, introduced into medicine in 1910, is, from the chemist's point of view, only a slight modification of the arseno-benzene known since 1875, but it required the genius of the pharmacologist Ehrlich to see how the comparatively simple process of the introduction of hydroxyl and amino groups into this old and uninteresting compound would result in a drug which has so changed the outlook in syphilis and other serious diseases.

The discovery of the anesthetic action of ether has been described as "the most important event in surgical, and one of the most important events in human history." You remember Weir Mitchell's lines:

Whatever triumphs still shall hold the mind,
Whatever gift shall yet enrich mankind,
Ah! here no hour shall strike through all the years,
No hour as sweet, as when hope, doubt and fears,
'Mid deepening stillness, watched one eager brain,
With God-like will, decree the Death of Pain.

But the introduction of ether had no effect upon the mortality of operations at the Massachusetts General Hospital. About two decades later, however, the number of operations began to increase at a rapid rate and there was a wonderful reduction in mortality. Operations scarcely dreamed of before were performed almost daily. A new drug, which was destined soon to have a greater influence upon medicine than ether, had been placed in the hands of the surgeon. And where had it been found? At a sewage disposal plant in Scotland. Lister thought that the carbolic acid which checked the putrefaction of sewage might check the putrefaction in wounds. This soon led to aseptic surgery, and another new era in medicine had begun. A medical orator stated: "Hand-in-hand, equal benefactors, anesthesia and asepsis march calm and triumphant"—but this impressive procession did not start for three hundred years after the discovery of ether and about fifty years after the discovery of carbolic acid.

Anesthesia and asepsis came when the medical profession had demonstrated to their own satisfaction that these were impossible.

How needlessly pessimistic have physicians been at times in regard to the discovery of new drugs is shown by that often quoted, or misquoted, but apparently not often read, essay on "Self-Limited Diseases" by Jacob Bigelow, one of the authors of the first edition of the U. S. Pharmacopoeia. Bigelow, writing in 1835, placed epilepsy and angina pectoris among the "self-limited diseases" in the sense that, as he says, the paroxysms of these "can neither be foreseen, prevented, nor, as far as we know, materially abridged in their duration."

How easily satisfied was Bigelow with the results from now almost discarded drugs is shown by his remark: "Thirty years ago, we might have added gout to the opprobrious list under consideration"; but states that gout might now be withdrawn from the list since colchicum and veratrum and abstinence from alcohol had so markedly lessened the frequency and violence of the attacks. The bromides, which are certainly far more efficacious in epilepsy than are colchicum and veratrum in gout, were well known to chemists when Bigelow wrote the above; amyl nitrite was discovered soon afterwards. Bigelow also made the remark, which seems never to be quoted: "In regard to the diseases which have been called self-limited, I would not be understood to deny that remedies capable of removing them may exist. I would only assert that they have not yet been proved to exist." However, in some mysterious way, this article, or the interpretation placed upon it, seems to have convinced the medical profession for generations that it is useless to look for new drugs of value. This attitude is strikingly evident in the dozen or more ether day addresses.

For many years ether day was celebrated with solemn pomp at the Massachusetts General Hospital; this was stated to be a day on which the adherents and friends of the hospital were accustomed to "take account of stock and to ask for such visions of the future as may guide it fruitfully." It might have been more appropriate to have observed the day as one of humiliation and repentance for the needless agonies inflicted in the three hundred years which elapsed between the discovery of ether and its application. But not one of the distinguished speakers seemed to have grasped the real meaning of the discovery: how it was possible to obtain with an ancient drug results which science and religion alike had taught to be impossible.

Nor was attention ever called to the fact that there were known in 1846 a number of drugs besides ether with which surgical anesthesia could have been discovered; nitrous oxide, ethylene, chloroform, ethyl chloride and bromide and acetylene were all well-known chemicals at that time.

The subject of surgical anesthesia was often treated as if it were a closed chapter; but steady progress is being made, as shown by the recent introduction or reintroduction of ethylene, and of various new local anesthetics, as well as of new general anesthetics. But the question should be seriously considered if man has even got on the right track in regard to general anesthesia. The effective anesthetic dose of the present general anesthetics is more than 50 per cent. of the

fatal dose—a smaller margin of safety than with any other class of important drugs. The essential action of anesthetics seems to be the blocking of the passage of impulses to the brain at certain synapses; impulses coming from the brain to peripheral organs may be blocked by drugs in a thousandth or even millionth of the fatal dose.

Another slogan which has done much to retard rational therapeutics is the "healing power of nature." Nature is certainly not very active in healing cancer, syphilis, tetanus, amebic dysentery, yaws, diabetes, myxedema, hookworm and many other diseases, many of which may now be relieved or cured by drugs. There is truth in Benjamin Rush's famous remark that nature should be turned out of doors and efficient art substituted for her.

Not only can the introduction of almost every modern drug into medicine be traced straight back to pharmacological experiments, but the rational use of some of the older remedies is almost wholly dependent upon such experiments. Even the underlying pathological conditions have often been elucidated by such work. To-morrow will be the twenty-fourth anniversary of the presentation to a medical association meeting in this hotel of a paper by two modest pharmacologists (the late Professor Cushny, and Edmunds, whom we have with us to-day) in which an explanation was offered for the first time of the condition (auricular fibrillation) in which digitalis produces its most spectacular results.

These pharmacologists were also largely responsible for the introduction into medicine of physiological standardization. Other pharmacologists, especially Hatcher and Eggleston, developed the subject farther and have done much to place digitalis therapy upon a firm foundation. Still, some of the latest model medical schools do not see any use in pharmacology; the faculties of the old proprietary medical schools often consisted of men of greater vision.

But it is not necessary to pursue this aspect of the subject farther; you would not be here if you did not have faith in drugs. But what are the possibilities of adding to the list of valuable drugs? Never in the history of the world have the possibilities been so great. When ether, chloroform, chloral hydrate, amyl nitrite, phenol, etc., were introduced into medicine, the number of synthetic organic chemicals was very few; they were numbered in hundreds, or at most in a very few thousands. A year of two ago the organic chemists had already carefully described the physical and chemical properties, method of synthesis, etc., of 258,000 organic compounds; about twenty new ones are being added to the list every day and, if there were a demand for them, they could be increased a hundred fold. Perhaps the pharmacologist would feel that a fair amount of knowledge is available as to the possible therapeutic value of two or three thousand of these; he can find casual references to some of the physiological effects of three or four thousand more, but, even with these, he is prepared for such surprises as occurred in connection with cocain, acetanilid, phenol, simple derivatives of arsenobenzene, etc.

Little indeed is being done to test these new compounds for possible medicinal value; at the present rate of progress it would require not only decades but centuries, perhaps a millennium, for the medical profession to examine what the chemists already have to offer.

No one doubts that an exact knowledge of the cause of disease may be of great value in its prevention or cure. But, in this topsy-turvy world, progress has not proceeded in a logical way. Some of the formerly most deadly diseases (smallpox and yellow fever) were the first to be effectually controlled, although even their causes are still unknown. More progress was made in the cure of malaria and syphilis long before their cause was discovered than in such diseases as pneumonia and tuberculosis, concerning which there is a large amount of exact knowledge. Only the most imperfect knowledge as to pathogenic bacteria was available when Lister revolutionized surgery and medicine by the use of phenol.

Empiricism gave us some drugs and poisons with a highly specific action: quinine and emetine ferret out and, under favorable conditions, destroy, the organisms of malaria and amebic dysentery; atropin paralyzes the ending of parasympathetic nerves; epinephrin stimulates the endings of the sympathetic; cocaine paralyzes the endings of sensory nerves, etc.

Pharmacology is duplicating these achievements of nature: malaria, amebic dysentery, syphilis, yaws, etc., yield to synthetic drugs.

There are many considerations which should tend to encourage the hope that a diligent and really intelligent study of the chemotherapy of cancer, for example, might lead to a cure before the cause is discovered. The highly selective action of drugs upon certain tissues is very suggestive; it was almost startling, for example, to have seen many cases in which methyl alcohol had destroyed a few cells in the retina and caused complete blindness, without there being the slightest indication of injury to other organs or tissues. May there not be in the vast number of known but untested compounds some which may have a similar effect upon the cancer cells? A person thinks again of the number of drugs known before 1846 with which anesthesia might have been produced.

Haphazard, random experiments in such a field avail no more than would similar experiments have

helped Ehrlich in his search for arsphenamine. Ehrlich's knowledge of chemistry and pharmacology was so enormous that he could quickly eliminate many compounds from further consideration; he would draw a circle and, after a few experiments, divide it into two and remark that only the compounds in one half of the circle seemed promising; later he would again draw a line and study the compounds in only one quarter, and so on.

Somewhat similar methods can and have succeeded in other fields of pharmacology, as well as in the chemistry of dyes. Ehrlich early recognized in cocain a group which he called an anaesthiophore group, analogous to the chromophore group of the dye chemist; the recognition of such groups has been the basis of the development of other local anesthetics.

The pharmacologist can already predict with a high degree of certainty what chemical compounds will have a "muscarine" or a "curare" or a "stimulating" or a "paralyzing" nicotin-like action. The central atom in such compounds may be nitrogen, sulphur, arsenic, etc.; but if certain side chains are present, the pharmacologist can be certain that the compound as a whole will have one or other of the above actions.

Time does not permit of more than the briefest possible consideration of the means by which work in this field can be speeded up. A comparison of the tenth with the fifth revision of the U. S. Pharmacopoeia indicates the progress made in fifty years. Among the important therapeutic agents added in this period are the arsphenamines, cocain and all other local anesthetics, every effective hypnotic, every analgesic (acetanilid, cinchophen, etc.), the salicylates, the nitrites, bromides, the antitoxins, nearly all the antiseptics, etc. Nobody questions for a minute the great value of these drugs. It is also evident that the United States has scarcely made a single really original contribution to this list. The great majority of these drugs were discovered in Germany and most of them in the pharmacological and other laboratories of the German universities or in special research institutes. At the present time, there is scarcely a university pharmacological laboratory in the United States the equal of a number in Germany forty or even fifty years ago.

There is no institute in the United States comparable to the one founded for Ehrlich at Frankfort in Germany. The contributions of Ehrlich to serum therapy had been so important that it was proposed to call the Frankfort institute a serum institute. Ehrlich, however, insisted that it be called an institute for experimental therapeutics and at the first opportunity practically abandoned work with serums and returned to pharmacology, to which he had already made important contributions. Just twenty-eight years ago, Ehrlich expressed the view that the "future of medicine lay in pharmacology." He was convinced, however, that the ideals of the pharmacologists had been unnecessarily low and chose to limit his work largely to one field of pharmacology which he later called chemotherapy. But the methods he pursued were the same as those he had used in his pioneer work on analgesic drugs, the therapeutic use of dyes and his fundamental work on cocain. (It may be remarked parenthetically that Ehrlich's famous side-chain theory originated from this cocain work; recently published letters of Ehrlich show the impatience he felt with what he called the stupid people who never realized that his conception of side-chains was wholly that of the organic chemist.) Ehrlich was able to make rapid progress in this field owing to his extraordinary knowledge of organic chemistry and his encyclopedic knowledge of pharmacology, and also his complete freedom in research.

It is not unusual in the United States for considerable sums of money to be made available for the discovery, for example, of a cure for cancer, an improved drug for syphilis, etc. Such gifts come from the heart rather than from the head. I saw such an experiment tried in Ehrlich's Institute. Ehrlich had accepted funds for a study of the therapy of cancer; the work began with enthusiasm, but after two or three years the workers were so discouraged that they placed a sign over their door: "Abandon hope, all ye who enter here"; and Ehrlich frequently warned, "Never, never accept money for one specific purpose." The history of arsphenamine was entirely different; the real beginnings of that work were so obscure and so unrelated to either syphilis or arsphenamine that they were never published, but the course can still be followed in the early laboratory note-books. First a purely theoretical study of the relation of the vinyl linkage in the quinine molecule to toxicity; there was no thought at that time of any possible relation of these compounds to pneumonia, but years later it was found that one of these came nearer to being of use in this disease than any previously known drug. The effects of the quinine compounds were studied upon various protozoa and then upon the organisms of sleeping sickness, but without encouraging results. Then pentavalent arsenic compounds were studied in connection with sleeping sickness, then various trivalent arsenic compounds, then arseno compounds. Finally, the arseno compounds were studied in connection with experimental syphilis of the rabbit, and the result was arsphenamine. Had Ehrlich been limited to a study of the compounds of quinine or sleeping sickness, or of any one group of arsenic compounds, arsphenamine might never have been discovered.

You remember how Woehler tried to make ammo-

nium cyanate and obtained urea, an observation which broke down the distinction between compounds formed as the result of so-called vital forces and ordinary carbon compounds, and how the experience of Woehler was compared to that of Saul, who was said to have gone forth to seek his father's asses and discovered a kingdom.

Conditions have never been as favorable for the development of such work in the United States as at present. Organic chemicals which a few years ago were imported from Germany in gram lots are now obtainable in tank cars. There are hundreds of chemists eager to cooperate with the medical profession in the investigation of these compounds for possible medicinal value. But not only are there at present few facilities for such work, but it is difficult for manufacturers to obtain trustworthy data even as to the possible poisonous properties of their products.

Within the last year or two funds aggregating nearly a million dollars have been available for research in pharmacology, some of which had very important bearings upon the treatment of disease and the public health, but great difficulty was found in finding laboratories equipped for such work; in many cases none was found.

Of course, we all appreciate what some American manufacturers are doing in this field; how, for example, they have completely relieved the humiliating situation in which the United States found itself at the beginning of the World War when no local anesthetics or modern arsenicals and few hypnotics were available. And American laboratory workers and physicians deeply appreciate the many courtesies and assistance which these firms are always ready to give. But, with a few notable exceptions, distinctly new fields have seldom been opened. The chances of making the books balance in work of this kind are small and not infrequently new drugs are placed on the market with the frank admission that there has been pressure from the sales department.

Pioneering work in this field has usually been done, as it should be done, in endowed institutions and has been pursued largely as a branch of pure science just as was the work which has led to the applications of electricity. It is just this pioneering work which at present is so much neglected in our universities and research institutions.

Perhaps some of those who have made large fortunes in the drug or chemical industry would be glad of an opportunity to aid in the founding of an institute analogous to that at Frankfort, the purpose of which was stated to be the study of therapeutics and which, under Ehrlich's direction, was devoted chiefly to the study of drugs. Recently, according to press reports, several million dollars acquired in the drug business were willed to a university; the undergraduate students are reported to be busy arguing whether this should be used for the promotion of athletics or for building more dormitories. Professor Lusk recently remarked: "We are building great comfortable homes for the students in our colleges; we are planning pent-house apartments for the internes in our hospitals. But who is concerned with the material welfare of the professor? The answer is, virtually no one. No pent-house apartments are thought of for him." But after all it matters little about the professors who are already in the work; they could not get out if they would. It is discouraging, however, to see almost every year brilliant and enthusiastic young men and women who are eager to undertake such studies but who soon learn that few institutions offer reasonably good facilities for such work and that the outlook for the future is very dubious in comparison with the opportunities in clinical work, not only as regards facilities, but also for advancement.

It is difficult to avoid the conviction that when the historian of the future discusses the present status of medical research in the United States, when he notes what the study of drugs has already meant to the human race and when he thinks of the quarter of a million or more untested preparations on the chemists' shelves, the present will seem one of the darkest periods in medicine; he may even find a parallel between the attitude of some of those now responsible for the trend of medical research and the complacency of Percival Pott who in 1779 thanked God that his contemporaries (who had ether but did not use it) were not cruel like their predecessors.

I can not conclude these remarks without again expressing my appreciation of the honor of being selected president of this organization. The contact with the officers of the convention and the members of the revision committee has been most pleasant, inspiring and profitable. As an *ex officio* member of the board of trustees, I have been privileged to see something of the business side of the work. No organization could have been more faithfully served. It has had the services of a wise and experienced chairman; those of two faithful and resourceful secretaries; a treasurer who not only looked after the financial problems with the greatest care, but who was always ready to help in a most practical way in any problem which arose; the modest, tactful, fair and broad-minded chairman of the revision committee.

The memory of the association with these and the other members of the board of trustees is one which I shall always treasure.

The convention has suffered severe losses by death,

including three vice-presidents and the secretary of the board of trustees.

It is a sad commentary upon the rate at which we live that it is impossible to do more than merely mention the names of men who devoted a lifetime to the problems in which we are so much interested—such men, for example, as the versatile and lovable Dr. Whelpley, and the charming and scholarly Dr. Power, who achieved preeminence in two countries by his important contribution to the knowledge of plant chemistry.

I can only ask the secretary of the convention to announce the names of the officials of the present convention who have passed away, and, in accordance with custom, ask you to stand for a few moments in honor of the dead.

OBITUARY

RALPH HAMILTON CURTISS

THE death of Dr. Ralph H. Curtiss, professor of astronomy and director of the Astronomical Observatories of the University of Michigan, which occurred on Christmas Day, 1929, brought grief to a wide circle of friends to whom he was endeared by the kindly and lovable traits of his character. To the world of science and to the university which he had served so faithfully and ably his loss is a grievous one. Both by his own researches and through the inspiration and wise counsel generously given to his students and coworkers, he has contributed notably to the advancement of astronomy. It is one of the tragedies of his untimely death that he was about to see the realization of the project for a new and larger observatory in a more suitable location for which he had planned and worked unceasingly. During his last illness the land for the observatory site was purchased, and it is to be hoped that the new edifice will be constructed in accordance with his plans as a fitting tribute to his memory.

Ralph Hamilton Curtiss was born at Derby, Connecticut, February 8, 1880, of Puritan parents, Hamilton Burton and Emily Wheeler Curtiss. The early training in this Puritan home, ordered in accordance with the fine traditions of the stock, left a lasting imprint upon his character and was reflected in many of the outstanding qualities which characterized his life —a high sense of duty and justice, untiring devotion to his work and a deep appreciation and love of scholarly attainments. In 1892 the family moved to Redlands, California, where young Curtiss received his elementary education, graduating from the local high school at the age of sixteen, with high honors.

After a year spent in working and saving to provide funds for his college education, he enrolled in the fall of 1897 as an undergraduate at the University of California, where for the next four years he not only maintained a high scholastic record, but entered enthusiastically into the many activities of student life. He was a good "mixer," popular in his fraternity, Delta Tau Delta, and in fact with all his associates, both students and faculty. To his genial and lovable traits was added the rare talent of a musician. He was a member of the University Glee Club and played the violin with unusual skill. Early in his academic career Curtiss was attracted especially to the science of physics largely through the influence and inspiration of the late Professor E. P. Lewis. Later he was drawn to astronomy by another great and inspiring teacher, Professor A. O. Leuschner, and he seems to have decided as early as his junior year to become an astronomer. Recognition of the excellence of his work as a student came through election to Phi Beta Kappa in his junior year, and of his standing in astronomy by his appointment the following year as an assistant in the Students' Observatory.

Early in 1901, with the requirements for graduation practically completed at the middle of his senior year, Curtiss was sent as a member of the Lick Observatory expedition to Padang, Sumatra, to observe the total solar eclipse of May 17–18. The degree of bachelor of science was conferred upon him by the University of California in 1901 during his absence on eclipse duties. There followed three years of graduate study in astronomy at Berkeley and Mount Hamilton, during which time he held one of the Lick Observatory fellowships. His work in this period laid the broad foundation for the future brilliant and successful career in his chosen field. He was equally conversant with the theoretical and the observational side, whether the subject lay in the older field of astronomy or in that of astrophysics. Keen and active of mind, skilful in the manipulation of instruments, untiring in his devotion to work, he was recognized by the members of both departments as a man of outstanding ability and scholarly attainments. At the Lick Observatory he made an extended spectrographic study of the Cepheid variable W. Sagittarii. In the course of this work he showed that low dispersion could be applied successfully to the determination of the radial velocities of stars of the later spectral classes through the use of a method which he developed for the measurement and reduction of the spectrograms. This method, to which he gave the name of "zero standard," satisfactorily eliminates the errors arising from uncertainties in the adopted wave-lengths of the lines produced by the effect of blend

and has since found wide application in radial velocity work. The results of this investigation were presented as his doctor's dissertation under the title "I. Proposed Method for the Measurement and Reduction of Spectrograms for the Determination of the Radial Velocities of Celestial Objects. II. Application to a Study of the Variable Star W. Sagittarii." The degree of doctor of philosophy was conferred upon him in 1905 by his alma mater.

In May, 1905, Dr. Curtiss was appointed assistant astronomer in the Allegheny Observatory, where the following two years were devoted, in collaboration with Director Schlesinger, to the initiation and development of the spectrographic program. When plans were formulated for astrophysical research at the Observatory of the University of Michigan, Dr. Curtiss was called to this institution in 1907 as assistant professor of astrophysics and placed in charge of the development of this phase of the observatory's activities. Under his supervision a spectrograph of one-prism dispersion was constructed from his design for use with the new 37½-inch reflector, and a program of spectrographic observations for certain interesting classes of stars was undertaken with marked success. Four years later he was promoted to associate professor and assistant director of the observatory and in 1918 became professor of astronomy. In March, 1927, he was appointed director of the Observatory of the University of Michigan in succession to William J. Hussey, whose death occurred while he was *en route* to Bloemfontein, South Africa, the station of the Lamont expedition for the observation of southern double stars. The work at this station was organized under the direction of Professor Curtiss in accordance with Professor Hussey's plans and is being ably carried on by Dr. Rossiter.

Since 1911, Professor Curtiss had not only directed the spectrographic program of research at the observatory, but had given graduate courses in spectroscopy and astrophysics, in addition to the more elementary work in descriptive astronomy in the university. During the war he offered courses in navigation, which were attended by hundreds, some of whom later saw service with the naval forces of the country. His lectures were clear and concise, and were presented in a careful and pleasing manner. He was an inspiring teacher and he had the faculty of imparting to his students some of his own high ideals of scholarship and enthusiasm for research. His students learned to respect and love him for his manly qualities, for the fairness with which he treated every question concerning them and for the sincere interest he took in their welfare. Most of those taking the doctorate in astronomy at the University of Michigan in recent years worked under his direction and the high quality of their researches is eloquent testimony to his ability as a scientific teacher and director of research.

Professor Curtiss's researches and those of his students were confined principally to the field of stellar spectroscopy, but in this they cover a wide variety of subjects. As the result of his earlier experience at the Lick Observatory he quite naturally turned his attention to the rich field offered by the use of low dispersion instruments and in particular to the application of such instruments to the study of stars having early type spectra, which on account of the character and small number of the lines are especially suited for observation in this manner. That this field proved a most fruitful one under his cultivation is shown by the number of important papers which came from his hand. His most extended investigation and one of his most important contributions relates to a study of Class B stellar spectra containing emission lines. The program of observations begun at Allegheny and continued at Michigan consisted, in addition to a few spectrograms on each of a number of these stars, of a long series of plates on several typical objects for a detailed study of the intensities and widths of the emission lines, and in particular for following the changes in intensity and position of the lines that occur in spectra of this class. These researches are described in detail in six memoirs appearing in the *Publications of the Detroit Observatory,* while the results of his more recent investigations on this subject were in course of preparation for publication when he was stricken with fatal illness.

From the beginning Dr. Curtiss realized that the solution of the problem of the physical nature of the Class B stars whose spectra exhibit bright lines was to be obtained only through a thorough and systematic study of these spectra and that to secure the necessary observations would require many years. It was along these lines that his investigations were planned. To unravel the intricate details on the fine series of spectrograms required no little patience and skill. Finally, the results were collected and their bearing upon the probable physical conditions existing in the stellar atmosphere critically discussed. Among the many important results of these researches we may note the interesting relation found to exist between the widths of the emission lines and their wave-lengths, a relation which he has interpreted on the basis of certain plausible assumptions concerning the distribution of vapor density at different atmospheric levels in which the various emission lines have their origin. Many of the perplexing problems concerning the peculiar behavior of the bright-line B stars still await the final answer, but as the result of Curtiss's researches a very important advance has been made toward the solution of some of these.

Studies of the two eclipsing variables, Algol and β Lyrae, made by Professor Curtiss have yielded most important information concerning these very interesting systems. In the former system he was able to show conclusively the presence of a third component having a period of 1.9 years. Minor irregularities in the observed velocity curve of Algol suggested another problem, solved several years later by one of his students at Michigan, Dr. D. B. McLaughlin, who found that these are produced by the rotation of the bright component. His pictorial study of the spectrum of Nova Geminorum II, representing the spectral changes in the star observed at the Michigan Observatory, furnished data of great value, which in combination with the observations of others enabled some of the more important variations occurring in the spectrum of this nova to be traced.

For the past few years Professor Curtiss had been engaged, with several of his colleagues and students, in an extended investigation of the difference in displacement shown by spectral lines originating at different levels in the atmospheres of Cepheid variables. This effect, discovered at the Michigan Observatory, is one of great importance in connection with the problem of Cepheid variation, and its final elucidation should throw considerable light upon the complex motion taking place in the atmosphere of a pulsating star.

Dr. Curtiss's published researches are contained in some eighteen memoirs, appearing in the *Publications of the Astronomical Observatory of the University of Michigan*, *Bulletin of the Lick Observatory*, *Publications of the Allegheny Observatory* and in astronomical journals. In addition he contributed a number of shorter papers to current astronomical literature. He had just completed the chapter on "Classification and Description of Stellar Spectra," which he was preparing for the fourth volume of the "Handbuch der Astrophysik." Several extended investigations were also in a well-advanced stage and it is hoped that these will be completed by his colleagues at an early date.

Recognition of his scientific work came to Professor Curtiss from many learned societies. He was a fellow of the Royal Astronomical Society, member of the American Astronomical Society, of the Seismological Society of America, Phi Beta Kappa, Sigma Xi, a fellow of the American Association for the Advancement of Science and a member of Commission No. 29 "On Stellar Spectra" of the International Astronomical Union.

Professor Curtiss is survived by his widow, Mary Louise Welton Curtiss, to whom he was married in 1920, and by a brother, Dr. David Raymond Curtiss, professor of mathematics in Northwestern University. Dr. Curtiss was fond of his home life and was never so happy as when playing the host to one of his colleagues. He took an active interest in civic affairs and in the social life of his community. In the world of science he was recognized as a leading authority on stellar spectra, our knowledge of which he has enriched through a long line of most fruitful researches. As an investigator he exhibited marked skill and originality in the treatment of difficult problems, patience and extreme care in the consideration of every detail of the work to the end that the data should have the maximum precision, and finally true scientific caution in the interpretation of his observational results. He was a scientist of wide vision and high ideals and possessed to an unusual degree the power of stimulating others.

J. H. MOORE

LICK OBSERVATORY

SCIENTIFIC EVENTS

THE UNITED STATES BUREAU OF FISHERIES

WORK on the nation-wide five-year construction and maintenance program has been begun by the Bureau of Fisheries in accordance with the act of Congress approved on May 31, according to an oral statement made by the Deputy Commissioner, Lewis Radcliffe, on July 8 to the *U. S. Daily*. One important feature of the act is that provision is made for cooperation between the bureau and states, counties, municipalities, individuals and public and private agencies.

The bureau may also accept donations of lands, funds and other aid to the development of the program under the provisions of this act. It authorized additional appropriations for new stations, laboratories and distribution cars to the amount of $1,885,000; annual increases in appropriation for the division of fish culture of $100,000, and increase in appropriation for the divisions of inquiry and fishery industries at the rate of $60,000 and $35,000 per annum for the five-year period, he outlined.

Of the increase for the fish culture division not more than 30 per cent. is for salaries and for the other divisions 40 per cent. The total increases for the fifth year authorized for the three divisions will be $50,000, $300,000 and $175,000, respectively.

Authorizations for new construction by years follow:

Fiscal year beginning July 1, 1930: Fish-cultural stations—New Mexico, $50,000; Louisiana, $50,000, an/

Idaho, $60,000. Substations—Wisconsin (southern), $50,000; Montana, $35,000; Colorado, $35,000, and New Hampshire (White Mountain Forest), $25,000. A fishery laboratory in Washington, $125,000, and an experimental bass and trout station, Maryland or West Virginia, $75,000.

Fiscal year beginning July 1, 1931: Fish-cultural stations—Alabama, $50,000; Indiana, $50,000; Tennessee (middle), $50,000, and Pennsylvania (including a substation), $100,000. Substations—South Carolina (or enlargement of Orangeburg station), $25,000; Texas (western), $35,000; New York, $35,000. The purchase of Mill Creek station in California, $20,000, and the purchase and repair of Rogue River substation, Oregon, $35,000.

Fiscal year beginning July 1, 1932: Fish-cultural station—Florida, $60,000. Fish-cultural substations—Maine (including enlargement Craig Brook), $50,000; Virginia (eastern), $75,000, and Minnesota, $50,000. A fishery laboratory in Texas (Gulf coast), $75,000, and the purchase or construction of steel fish-distribution car, $75,000.

Fiscal year beginning July 1, 1933: Fish-cultural stations—Nevada, $60,000; Illinois, $75,000, and New Jersey, $75,000. Substation — Mississippi (southern), $50,000, and the purchase or construction of steel fish-distribution car, $75,000.

Fiscal year beginning July 1, 1934: Fish-cultural substations—Ohio, $35,000; Kansas, $35,000; North Dakota, $35,000; Georgia, $35,000, and the purchase and repair of Little White Salmon station in State of Washington, $35,000. A fishery laboratory in the territory of Alaska, $50,000, and an experimental and bass and trout station in Pisgah National Forest or Great Smoky National Park in North Carolina, $35,000.

AWARD OF THE STORROW FELLOWSHIPS

THE Storrow fellowships in geology and geography are based upon a fund of $5,000 placed with Mr. Arthur Keith, chairman of the division of geology and geography of the National Research Council, by Mrs. J. J. Storrow, of Boston, Massachusetts, for the promotion of training in research in those branches. In the allocation of the fund the committee on fellowships of that division has given primary consideration to aiding outstanding students in these fields to make successful beginnings in research careers, rather than to securing advanced degrees. It has even held that it is not necessary for the candidate actually to be engaged in university study at the time of his application for aid in further training.

Following are the recipients announced by the committee through the National Research Council: H. J. Fraser, Cambridge, Massachusetts; Norman Hinchey, St. Louis, Missouri; Ralph L. Lupher, Pasadena, California, and Jerome S. Smiser, Princeton, New Jersey.

So meritorious were the cases presented that the fund was fully allocated for the coming year. Nothing could more unmistakably show the great need for research fellowships available to graduate students in geology and geography than the applications and supporting letters received since the announcement of these fellowships was published in SCIENCE in mid-January. They reveal the existence of a large group of young men of fine character and ability who have graduated from the universities and who are pressing for special training with a view to entering definite research careers in different branches of our subject. Applications stating present training and specific research objectives and plans are supplemented by letters relating to the character, training, ability, industry and special aptitude of the candidates for the particular line of work in view. Among the group of selected cases remaining there are enough of distinctly high rank and promise to make profitable use of a fund of $20,000 a year. Some of these cases are opportunities to launch trained and ambitious young men into productive contribution to the knowledge of geology and geography.

Most of the applications relate to geology, and of these more of the outlined plans lie in the fields of invertebrate paleontology than in any other single subject. Four applications fall within the broad province of geography.

A very interesting though small group of applications are from men no longer in the universities who have developed perspective and purpose relating to certain fields or problems of research which they wish to enter upon but which they can not undertake without aid or for which they can not insure the necessary preparation without funding which, in most cases, is on a very modest scale.

The committee hopes that the demonstration of desire on the part of young men and women to engage in research in geology and geography, the ability and earnestness of purpose indicated, and the generally practicable as well as meritorious plans in view will appeal to persons of means who are interested in the promotion of research in geology and geography.

DAVID WHITE,
Chairman, Committee on Fellowships
DIVISION OF GEOLOGY AND GEOGRAPHY,
NATIONAL RESEARCH COUNCIL

AWARDS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

FOR outstanding achievement five engineers received awards at the opening session of the sixtieth annual convention of the American Society of Civil Engineers which opened at Cleveland on July 9.

A gold bronze medal, the first prize in the annual Phebe Hobson Fowler professional award, was be-

stowed upon Arthur W. Berresford, of New York, "in recognition of his particularly efficient administration of the American Engineering Council during the two years of his incumbency as its president."

Since his retirement as head of the council on December 31, Mr. Berresford has been managing director of the National Electrical Manufacturers Association. The council was organized in 1919 as the public-service body of the engineering profession of the United States with Mr. Herbert Hoover as its first president.

Mr. Berresford was born in Brooklyn, N. Y., July 9, 1872. He is a graduate of Brooklyn Polytechnic Institute and of Cornell University. He is a past president of the American Institute of Electrical Engineers, of the Associated Manufacturers of Electrical Supplies and of the Electrical Manufacturers Club. He is a former vice-president and general manager of the Cutler-Hammer Manufacturing Company of Milwaukee, with which he was connected from 1900 to 1923. He was also vice-president of the Electrical Refrigeration Corporation of Detroit, now the Kelvinator Corporation. He is a member of numerous organizations, including the American Society of Mechanical Engineers, the Society of Naval Architects and Marine Designers and the Detroit Engineering Society.

A silver bronze medal, second prize in the Phebe Hobson Fowler award, went to J. Vipond Davies, of New York, "in recognition of his accomplishment as chairman of a committee of the American Society of Civil Engineers which developed the 'Report on Charges and Method of Making Charges for Professional Services,' adopted by the Society."

Mr. Davies was president of the United Engineering Society from 1920 to 1923. From 1920 to 1928 he was a member of the Research Board of the Engineering Foundation. He was born in Swansea, South Wales, on October 13, 1862, and is president of Jacobs and Davies, Inc., consulting engineers of New York City. He has been associated with many important engineering enterprises.

Three engineers received prizes in the Phebe Hobson Fowler architectural award as follows: First, Morris Goodkind, of New Brunswick, N. J., for the design of the Raritan River Bridge at New Brunswick; second, Professor Charles M. Spofford, Massachusetts Institute of Technology, for the design of the Lake Champlain Bridge; third, George F. Burch, of Springfield, Ill., bridge engineer of the Illinois Division of Highways, for the design of the Dixon Springs Bridge, Dixon Springs, Ill.

The awards were established by Charles Evan Fowler, consulting engineer, of 25 Church Street, New York, a member of the American Society of Civil Engineers, in honor of his mother.

AT THE UNIVERSITY OF MISSISSIPPI

The board of trustees of the University of Mississippi at the end of June dismissed a large part of the faculty without warning and without other than political reasons. In addition to the chancellor, Dr. Alfred Hume, those dismissed include:

Dr. P. W. Rowland, professor of pharmacology.
Dr. D. H. Bishop, professor of English and head of the department.
Professor J. H. Dorroh, professor of engineering and dean of the School of Engineering.
Dr. J. O. Crider, professor of physiology and dean of the School of Medicine.
Dr. J. N. Swan, professor of chemistry and head of the department.
Dr. C. N. Wunder, dean of men, professor of mathematics and head of the department.
Dr. W. D. Hedleston, professor of philosophy and head of the department.
Robert Torrey, associate professor of mathematics.
L. D. Wallace, associate professor of English.
Mrs. E. L. Eatman, dean of women and professor of home economics.
K. P. Vinsel, associate professor of political science.
Robert Farley, assistant professor of law.
William Hemingway, professor of law.
R. E. Grim, assistant professor of geology.

The Jackson *Daily News* of June 29 says editorially:

> Professors who have given the best years of their lives to the training of the youth of Mississippi, men eminent in the world of education, were summarily dismissed to make way for administration favorites. In a number of instances successors chosen are without experience or qualification for the work they will undertake at the next scholastic term. Men of scholarly attainments grown old in the service, but still highly efficient, are ruthlessly booted out to make way for others whose only claim to recognition is that they need jobs, or better jobs than they thus far have shown ability to fill. The University of Mississippi has been well-nigh slaughtered to make a Roman holiday and when the new chancellor takes charge he will face a task that few men would dare assume.

A correspondent writes: "It is to be hoped that university professors throughout the country will make sure that each of those dismissed is offered a suitable position for the coming academic year."

SCIENTIFIC NOTES AND NEWS

THE Lóczy Memorial Medal of the Hungarian Geographical Society of Budapest, founded to commemorate its former president, Professor Lewis Lóczy, and given in alternate years to a Hungarian and a foreign geographer, has been awarded to Professor W. M. Davis, of Harvard University, "in appreciation of his valuable work in the domain of geomorphology."

DR. R. R. SPENCER, of the U. S. Public Health Service, was awarded the gold medal of the American Medical Association at its annual meeting in Detroit "for original work in preparation of a vaccine for Rocky Mountain spotted fever."

AT the one hundred and fifth annual commencement exercises of Jefferson Medical College, Philadelphia, an honorary degree of doctor of public health was conferred on Dr. Andrew A. Cairns, director of public health of Philadelphia, and a degree of doctor of science on Dr. William Darrach, dean and professor of clinical surgery, Columbia University College of Physicians and Surgeons, New York.

DR. ELIAS P. LYON, dean of the University of Minnesota Medical School, was recently awarded the degree of doctor of science by the University of Southern California.

WESLEYAN UNIVERSITY conferred at commencement the doctorate of science on Dr. Victor C. Myers, professor of biochemistry at Western Reserve University, and on Harold D. Arnold, of the Bell Telephone Research Laboratories of the New York Telephone Company.

THE Royal Faculty of Physicians and Surgeons of Glasgow has decided to confer the distinction of its honorary fellowship upon the three following members of the medical profession: Dr. Robert Muir, professor of pathology in the University of Glasgow; Dr. William London Reid, lecturer on midwifery and gynecology in the Anderson College of Medicine, Glasgow, and Lieutenant Colonel Laurence Austine Waddell, professor of chemistry and pathology at the Calcutta Medical College.

THE Hamilton County Nature Study Club gave on June 14 at Noblesville, Indiana, a dinner in honor of Dr. W. S. Blatchley. Addresses were given on "Blatchley the Man," by Dr. David Mottier, of the department of botany, Indiana University; "Blatchley the Entomologist," by Mr. E. V. Rutherford, principal of Noblesville High School; "Blatchley the Naturalist," by Mrs. H. H. Beals, member of the Nature Study Club; "Blatchley the Geologist," by Dr. E. R. Cumings, professor of geology, Indiana University, and "Blatchley the Neighbor," by Mr. Fred Starr, superintendent of schools, Noblesville, Indiana.

AT a recent election the following officers were elected by the American Society of Plant Physiologists: *President*, Professor H. R. Kraybill, Purdue University; *Vice-president*, Dr. W. E. Tottingham, of the University of Wisconsin; *Secretary-Treasurer*, Professor Wright A. Gardner, of the Alabama Polytechnic Institute.

DR. WILLIAM M. JARDINE, head of the Federated Fruit and Vegetable Growers Association, formerly president of the Kansas Agricultural College and later Secretary of Agriculture, has been appointed minister to Egypt.

DR. RICHARD E. SCAMMON, A.B. and A.M. (Kansas), Ph.D. (Harvard), since 1914 professor of anatomy at the University of Minnesota, has been appointed professor at the University of Chicago.

DR. W. EDWARD CHAMBERLAIN, San Francisco, has been appointed professor of roentgenology and radiology at Temple University School of Medicine, Philadelphia.

PROFESSOR L. T. HOGBEN, of the University of Capetown, has accepted the new chair of social biology at the London School of Economics, University of London.

DR. J. L. SIMONSEN, lately professor of organic chemistry at the Indian Institute of Science, Bangalore, and Mr. F. W. R. Brambell, Lloyd Roberts lecturer in zoology, King's College, London, have been appointed professors of chemistry and zoology, respectively, in the University College of North Wales, Bangor.

DR. C. I. BLISS, of the Bureau of Entomology, will have charge of the technical investigations conducted by the bureau at the new regional laboratory of the tropical, subtropical and ornamental plant insects division, at Whittier, California. The work will deal especially with the resistance to hydrocyanic-acid gas of scale insects affecting citrus fruits.

SURGEON GROVER A. KEMPF, of the U. S. Public Health Service, has been designated a delegate on the part of the United States to the second International Pediatric Conference which opens at Stockholm on August 18.

DR. TAKAO MATSUNO, professor at the agricultural high school of Gifu, Japan, is visiting the United States.

DR. CARL WALTER KOCKEL, of the Geological Institute of the University of Leipzig, will be visiting pro-

fessor of structural geology at the Johns Hopkins University during the next academic year.

THE following nominations for officers of the American Society of Mechanical Engineers for 1931 were announced at a recent meeting of the nominating committee held at Detroit, Michigan, during the semi-annual meeting of the society. Election will be by letter ballot of the entire membership, closing on September 23, 1930: *President,* Roy V. Wright, managing editor, *Railway Age,* New York; *Vice-presidents,* William A. Hanley, chief engineer, Eli Lilly Company, Indianapolis; Thomas R. Weymouth, president, Oklahoma Natural Gas Corporation, Tulsa; Harvey N. Davis, president of the Stevens Institute of Technology, Hoboken, New Jersey; *Managers,* W. L. Batt, president, S. K. F. Industries, Inc., New York; H. L. Doolittle, chief designing engineer, Southern California Edison Company, Los Angeles; H. L. Whittemore,, chief of the engineering mechanics section, Bureau of Standards, Washington, D. C.; *Representatives on the American Engineering Council,* W. R. Webster, Bridgeport, Connecticut; R. V. Wright, New York, N. Y.; J. W. Roe, New York; Robert Yarnall, Philadelphia; E. N. Trump, Syracuse; B. E. Hull, Houston, Tex; E. O. Eastwood, Seattle; W. Trinks, Pittsburgh; Warner Seely, Cleveland, O., and William S. Conant, Washington, D. C.

AT the meeting of the American Association of Museums, held at Buffalo, N. Y., a new section was organized, to be known as the "Scientific Section," intended to include museum curators and others interested in museum problems related to the scientific work as contrasted with the purely educational function. The need for this was evidenced by the large attendance present at the evening meetings. The following sectional officers were elected: *Chairman,* Dr. Roy W. Miner, curator of lower invertebrates, American Museum of Natural History, New York; *Section Secretary,* Dr. Charles J. Fish, director, Buffalo Museum of Science; *Recording Secretary,* Mrs. Margaret Rodgers, Buffalo Museum of Science. The following program was presented, discussions following the reading of the papers: (A) Making Scientific Collections—"Field Work for a Scientific Museum," by Dr. Charles J. Fish, of the Buffalo Museum of Science; (B) Analyzing Scientific Collections—"Problems of the Study of Scientific Material in the Museum," by Dr. Waldo L. Schmitt, of the U. S. National Museum, and (C) Utilizing the Scientific Collections—"The Use of Living Material in Museum Work," by Dr. Frank E. Lutz, of the American Museum of Natural History.

PROFESSOR FRANK DEBENHAM, of the department of geography, Trinity College, University of Cambridge, England; Dr. H. Schneiderhöhn, direktor des Mineralogischen Instituts, University of Freiburg; Dr. P. Remdohr, professor of mineralogy at the Mineralogisches Institut der Technischen Hochschule, Aachen, and Dr. Otakar Matousek, professor of geology at the Charles University, Prague, are members of the International Summer School of Geology and Natural Resources of Princeton University. Professor Richard M. Field, of the department of geology, is the director. The trip began on June 27 and will extend to August 7. As an essential part of its program, the school offers a course called "The Geology and Natural Resources of North America." This course is given in the field, the party traveling in a specially constructed sleeping, dining and lecture car. The trip this year will cover approximately 11,000 miles in the United States and is planned as a practical demonstration of the relation of geology to natural resources and problems of their utilization. The subjects to be covered as types are: Fuel and power; structural materials, metallics and non-metallics; climate and agriculture; physiography, and transportation and trade. The principal localities which will be visited are: New York Harbor; New Jersey, clay industries; Johnstown, coal and steel; St. Louis, river port and trade; Bedford, stone quarries; Joplin, lead and zinc; Tulsa, oil geology; Fort Worth, cotton and cattle; Grand Canyon; San Bernardino, citrus fruits and southern reclamation; San Francisco, Pacific Port; Sierra Nevada, gold mines; Kelso, lumber; Washington (State), northern reclamation; Coeur D'Alene, silver; Butte and Anaconda, copper; Yellowstone Park; Big Horn Basin; Colstrip, coal; St. Paul, transportation and wheat; Hibbing, iron; Duluth, lake shipping; Detroit, manufactures; Chicago, packing and commerce; Niagara Falls, water power.

THE Second International Congress of Comparative Pathology will be held at the Faculty of Medicine in Paris, from October 14 to 18, 1931, during the French colonial exhibition. Professor Achard will be the president, and the subjects to be discussed include tuberculosis, cancer, psittacosis, the ultra-viruses, undulant and *abortus* fevers, anaphylaxis and milk. Further information may be obtained from the general secretary, Dr. Grollet, 7, rue Gustave Nadaud, Paris, 26ᵉ.

THE scientific society "Antonio Alzate" has organized a second Scientific Congress to be held in the City of Mexico from September 9 to 15. Scientific excursions, and visits to museums, libraries, etc., have been arranged. The congress will meet in eight sections, as follows: *Philosophy*—psychology, logic and ethics; *Sociology*—statistics, political economy, law

and public administration, and teaching and education; *Linguistics and Philology*—general glotology, languages and Indian dialects; *Mathematical Sciences*—pure mathematics, astronomy and geodesy; *Physical Sciences*—physics, chemistry and physico-chemistry; *Natural Sciences*—mineralogy, petrography, geology, paleontology, meteorology, terrestrial magnetism, botany, zoology, anthropology and ethnology, and biology; *Applied Sciences*—medicine and pharmacy, mining, agriculture, civil, military and naval engineering, and architecture; *Eighth Section*—geography, history and archeology.

THE late Dr. William J. Matheson bequeathed $20,000 to the endowment fund of the Long Island Biological Association at Cold Spring Harbor. Dr. Matheson was president of the board of managers of the laboratory for some years previous to its incorporation with the Long Island Biological Association.

THE University of California Museum of Anthropology has received a gift of approximately three hundred tobacco, hasheesh and opium pipes from all parts of the world that have been collected by Dr. W. A. Setchell, professor of botany of the university and chairman of the department during the past thirty years. The collection is intended to show how the common man has adapted and modified pipes to suit local conditions in all parts of the world, chiefly for the smoking of tobacco, which is native to the Americas and was unknown elsewhere until the coming of Columbus. In all there are some 24 from California Indians, 15 from North American Indians, 16 from Central America, 25 from Africa, 91 from Europe, 48 from Asia, 23 from the Philippines, 33 from the South Seas, 3 from South America and others unclassified.

THE *Journal* of the American Medical Association reports that in connection with its eighteenth public assembly, which was held in Heidelberg, May 26, the Emperor William Society for the Promotion of Sciences dedicated the newly erected Institute for Medical Research. The institute, which is located on the bank of the Neckar, combines four independent institutes: the Pathologic Institute, under the direction of Geheimrat Professor von Krehl; the Institute for Physics, under the direction of Professor Dr. Hausser; the Physiologic Institute, under Professor Meyerhof, and the Institute for Chemistry, under Professor Kuhn. The building is a three-storied brick structure, with beautiful lines. The central idea of the institute is the knowledge that the development of modern medicine is closely dependent on the progress of chemistry, physics and physiology. Eminent chemists, physicists and physiologists will undertake here, with a corps of assistants versed in medicine and the natural sciences, research in fields that lie between the sciences and medicine.

MR. VILHJALMUR STEFÁNSSON arrived on June 27, according to the London *Times*, at Southampton from Canada by the *Empress of Scotland* for the purpose of addressing the British Polar Congress on the economic aspects of the Arctic, with special reference to transatlantic flying; and also of engaging in research work at the laboratory of the Royal Geographical Society. In conversation, he said that the British Arctic Air Route Expedition which would set out from England in July was extremely important, for it was planned to survey what was undoubtedly the only practical aeroplane route by which Europe could be linked with the American continent, namely, *via* Scotland, the Faroes, Iceland, Greenland, Baffin Island, and thence to Canada. On that route there was not a single "jump" of more than 300 miles, which would enable an aeroplane to pick up fuel at economic intervals and so carry a maximum pay load. It would not be a very cold journey except over Greenland.

MR. J. E. NEWMAN, of the Institute of Agricultural Engineering, University of Oxford; Mr. Baxter, representing the Farmers Union of Great Britain, and Mr. George Clarke, representative of the Agricultural Laborers of England, are members of a commission that is spending five months in a study of the general methods of agriculture and the application of modern machinery and implements. The members have studied wheat growing in the Dakotas and Saskatchewan, Canada; fruit growing in British Columbia, the Pacific Northwest states and California; vegetable production in California and sugar beets in California and Colorado. The commission is visiting various institutions concerned with agricultural engineering and farm machinery.

ACCORDING to an Associated Press dispatch a group of Russian scientific men led by Professor Otto Schmidt and including Professor R. L. Somoilovitch, Professor D. U. Wiese and several others left on July 4 for Archangel, where they will embark on an icebreaker for Fridtjof Nansen Land, formerly Franz Joseph Land, to explore its possibilities of development. The expedition is equipped with supplies for 15 months. Its members will visit areas upon which no human foot ever before trod. They will explore the Isle of Isolation in the Kara Sea and a considerable part of the polar ocean. They will bring radio operators and other technicians to relieve the present staff of the world's most northern radio station on Nansen Island. The explorers will place upon "North Land," formerly Nicholas II Land, colonists to form a nucleus of a future Russian settlement.

DISCUSSION

INTERNATIONAL COOPERATION IN GEOMORPHOLOGY

THE progress of research in the science of land forms has been carried on without the help of special journals devoted to its development. In the United States most of the papers on the subject have been published in geological serials and a few in geographical serials. The science has also been unfortunate in the lack of agreement as to name. In America it is usually called physiography—an indefinite term. The more appropriate "geomorphology" suffers the disadvantage of length.

Through the enterprise of Austrian geologists and geographers an international journal for the publication of papers on land forms was established in 1926. The *Zeitschrift für Geomorphologie* is edited by Professor Andreas Aigner, of the University of Graz, Austria, and is published by Gebrüder Borntraeger in Berlin at a price of 36 reichsmarks for each annual volume. It is now in its fifth volume and is highly creditable to its sponsors.

Planned as an international journal, it will accept papers dealing with the origin and development of land forms in the principal languages, German, English, French and Italian. Because the initiative has been wholly in the hands of Austrian and German scientists, nearly all the papers so far published have been in German. Contributions in other languages will be welcomed and papers which present material on the larger features of North America or which set forth the American view-point on geomorphological problems are especially desirable.

The four volumes of the *Zeitschrift* that have appeared are particularly noteworthy in quality and in the range of subject-matter. The minor phenomena of erosion, under differing conditions of climate and location, are the subject of articles by von Seidlitz on "spouting holes" due to wave erosion, by Paschinger on "double ridges" in mountain areas, by Bryan on niches and cavities in sandstone, by Stiny on a landslide in Spain, by Brandt on the channel phenomena of streams in an area of low water table, and by other notable authors. Observations in arid regions are set forth by Schultz on the eastern part of the Karakorom desert, by Machatsek on Central Asia and by Passarge and Mortensen on the Inselberg problem. Several articles deal with the Mediterranean region of seasonal aridity, such as that of Winkler on the Island of Mallorca. There are a number of thoughtful articles which make plain the German view-point on general questions of morphological development now so largely influenced by the work of Walter Penck. Among these may be mentioned an article by Braun, once a follower of Davis, who now repudiates the "Cycle of Erosion" as impossible. The short article by Serge von Bubnoff on the piedmont steps of the southern part of the Black Forest is an interesting comment on the work of W. Penck in which it is shown that he confused resurrected pre-Triassic surfaces with more recent partial peneplains.

In addition to original papers the *Zeitschrift* contains reviews of current literature by the editor, Professor Aigner, and also by a distinguished list of associates including Brandt of Prague, Creutzberg of Danzig, F. Jaeger of Basel and Panzer of Berlin. Reviews of the geomorphological literature of North America will be prepared by the undersigned and the geomorphologists of the country are invited to cooperate by sending him separates of their articles in order that no worthy work may be overlooked. Reviews and notices of North American literature began to appear in the April issue of the *Zeitschrift* (Vol. V, Pts. 1 and 2). Articles by American authors intended for publication in the *Zeitschrift* should also be sent to him for transmission to the editor. It is desirable that these articles should deal with principles or with questions and problems of general interest.

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THE PARAGOULD METEOR AND METEORITES

ON the morning of February 17, 1930, at 4:08 A. M., C. S. T., a meteor, hereafter referred to as the Paragould meteor, fell about fourteen miles southeast of Paragould, Arkansas. A large stone whose weight has been determined as 820 pounds and a smaller stone weighing about 80 pounds have been recovered. A third small stone, weighing a fraction of a pound, which was found the day after the fall of the meteor, may be an authentic meteorite. Only a hasty inspection of the little stone was made, however, as the finder would not part with it at the time he was interviewed.

No computation of the path of the meteor through the atmosphere has as yet been made, but a preliminary examination of reports from several states shows that it came from the northeast at a rather low angle. Its velocity was less than that of the average fireball which we have investigated. Its brilliancy was such that at the distance of St. Louis more than one observer reported that he thought an airplane was going down in flames near the local airport. The meteor burst, and one observer at a distance of sixty

or seventy miles claimed he had distinguished three distinct pieces. It became invisible very quickly after bursting, the height of disappearance being about five miles, an unusually low altitude, even where meteorites have been recovered.

Following the disappearance of the brilliant meteor, residents of northeastern Arkansas and the adjoining territory in Missouri and Tennessee were startled by the crash of an explosion followed by a roll like thunder. In the immediate vicinity of Paragould the explosions were severe enough to awaken practically every one from sleep and to stampede stock on the farms. About seventy miles from the point of the fall, at Poplar Bluff, Missouri, the night officer on police duty visited all the banks, thinking that one of them must have been dynamited. Few appear to have been awakened by the explosions at that distance, but an observer of the meteor, at Ripley, Tennessee, reports that her mother was awakened from sound sleep by the explosion, which sounded like a blast of dynamite or a sharp clap of thunder.

Interviews with persons in the immediate vicinity of the fall indicated that the direction of the sounds could not be determined as definitely as when detonating meteors fall in broad daylight. At this hour, 4 o'clock in the morning, nearly every one was indoors, and consequently the reports were less definite as to the direction from which the explosions and sounds came. They do, however, determine reasonably well the location of the two big meteorites which have been recovered and suggest a third large stone which has not been found.

The large meteorite struck in a pasture and went down in rather stiff clay soil to a depth of $8\frac{1}{12}$ feet. This figure is the depth of the hole after the meteorite was removed, that is, the depth to which the bottom of the stone descended. In going down this distance, the stone deviated about one foot to the southwest, the direction of the travel of the meteor. The impact threw a few scattering clods of clay as far as fifty yards. At a distance of thirty feet from the hole the clods were fairly numerous. The eighty-pound stone also struck in a pasture, and the hole from which it was removed was measured as being thirty-four inches deep by a competent civil engineer who also assisted in measuring the hole made by the larger stone. The farmer who found and removed this stone reported that it had entered at a low angle from the southwest, but the civil engineer believed that he was mistaken—that he had been deceived by the way the dirt had fallen into the hole about the stone. From an examination of the marks made by the stone in its descent, the civil engineer reported that it had come from the northeast. As it is known that the meteor came from the northeast, this seems more probable, but from general considerations, we would expect the descent of the stone to be nearly vertical at the time of striking.

The general color of the broken surface of meteorites is, in most cases, a dark, slightly greenish gray. There is, however, much material of a lighter gray. The crust of the larger stone is unusual, and the pitting is not as distinctive as for most meteorites. The smaller stone has a well-developed "brustseite," quite smooth and light-colored. This surface shows scarcely a trace of crust and has hardly a suggestion of pitting. The opposite side, however, shows a strong black crust and is characteristically pitted. An examination of the surface of the larger stone shows grains of nickel-iron standing in relief, while the troilite is depressed. In thin section, chondri can be seen with a microscope. A preliminary chemical analysis has been made by Dr. K. W. Ray, of the chemistry department of the University of Iowa.

The smaller stone is now in the possession of Stuart H. Perry, of Adrian, Michigan, and the large stone is in the possession of the Field Museum of Chicago. A preliminary description of the smaller stone by Mr. Perry appeared with our announcement of this meteor in the April, 1930, issue of *Popular Astronomy*. The 820-pound meteorite is the largest stony meteorite which has been recovered intact. It is exceeded in weight only by the Long Island, Kansas, stone which weighed more than 1,200 pounds, but was broken by striking on a rocky ledge at the time of its fall. The date of fall is not known for the Long Island meteorite. The big Paragould meteorite is exceeded in weight by many irons, but for only one of these is the date of fall given in catalogues of meteorites. This is the Bezerros iron which is listed as having fallen in Pernambuco, Brazil, on May 9, 1915. The estimated weight of this big iron is twenty tons. The second iron in size for which the date of fall is listed is the Boguslavka, which fell on October 18, 1916. The larger iron in this fall weighed about 438 pounds. The third iron for which the date of fall is known fell near Cabin Creek, Arkansas, on March 27, 1886, and weighed 107 pounds. This Arkansas meteorite has for many years held the record as the largest iron for which the date of fall is known, and most recent books still list this as the record for dated irons. It appears that Arkansas has lost the record in dated iron meteorites but now has the record in stone meteorites for which the date of fall is known as well as for stony meteorites recovered intact.

For much information on this meteoric fall, the writer is indebted to W. R. Heagler and Rupert C. Wright, of Paragould, Arkansas. Mr. Heagler, a civil engineer, gave four days of his time to driving over the territory with the writer and securing

interviews with persons who had heard and seen the meteor. He also investigated the hole made by the small stone immediately after the fall and assisted the writer in examining and measuring the hole made by the large stone. Mr. Wright, the editor of the Paragould *Daily Press*, cooperated fully, especially in securing information to supplement that obtained by the writer at the time of his visit.

The last fall of meteorites in the United States, so far as is known to us, was at Tilden, Illinois, on July 13, 1927. The November 11, 1927, issue of SCIENCE carried our announcement of the Tilden meteor and meteorites.

Note added July 3, 1930:

The report of the fall of a big meteorite near Bezerros, Brazil, has not been verified. Among definitely authentic meteorites, iron or stone, the big Paragould is the largest for which the date of fall is known.

C. C. WYLIE

STATE UNIVERSITY OF IOWA

OCCURRENCE OF MAMMOTH AND GIANT BISON IN GLACIAL MORAINES IN THE HIGH MOUNTAINS OF COLORADO

IN June, 1929, the writer, accompanied by Professor J. Hansen, of Western State College, Gunnison, Colorado, and Mr. L. Q. Coffin, examined a reported fossil deposit which had been cut into during the course of the construction of a large ditch in the mountains between Gunnison and Montrose, Colorado. This ditch was built along the west side of the mountain valley of the Little Cimarron, and the deposits are found at an elevation of about eight thousand feet.

The principal formation here is Graneros beds of the Colorado group of the Upper Cretaceous, and they here contain some beautifully preserved fossil fish, with iridescent colors. So far as the writer is aware, these have never been collected and studied from this area.

Pleistocene deposits of coarse gravel, silt and boulders of all sizes lap down over these beds, and most of this appears to be old glacial moraines. In the limited time available for examination of these beds, so far as observed the spots where the fossils were found appeared to be clearly in beds of this origin and near their lower termination.

At Montrose, Colorado, the writer saw some of these bones which had been removed from the deposit. Portions of teeth and a tusk were preserved, not distinguishable from the mammoth type commonly referred to *E. columbi*. With this material was a molar tooth of a very large fossil bison, of the size found in the immense *B. latifrons* and similar species. The writer has had occasion the past year to study several of our extinct bison types, and it is evident that much individual variation exists in many characters, so that, at least until critical studies of all known material has been made, it is unsafe to attempt to identify these species by a single molar tooth.

While scattered, these fossils had been in a good state of preservation when found, and were well mineralized; but the rough handling they had received, with nothing done to preserve them, had naturally resulted in a good deal of damage being done to them.

Mr. L. G. Coffin, the father of the young man who accompanied the writer, was constructing the ditch and discovered the fossil bones. When in Denver recently he assured the writer that the large bison horns he found there were longer than, but not quite so robust as, an immense set of *Bison latifrons* horns now in the Colorado Museum of Natural History, Denver, which were found in the early Pleistocene of Nebraska. These horns are of almost the known limit in size, though not so long as in *Bison regius*. While the writer did not see the specimen, Mr. Coffin is known to be a man of reliability and the finding of one of these immense bisons, agreeing in size with the above mentioned molar, in association with *Elephas cf. columbi*, conforms with their known occurrence, save for being found at such a high elevation and in local glacial deposits.

So far as the writer is aware this is the first known occurrence of such fossils under these conditions in these mountains, and it brings up some interesting problems which should be studied.

To reach the spot where these fossils were found, one turns off at Cerro, about seventeen miles east of Montrose, on the main highway to Gunnison, and drives twelve miles up from Cerro to the Tripler camp. The Pleistocene fossils were found about one fourth to one half mile above this camp, in the ditch cut.

The Cretaceous fish mentioned are also found near here, in a slide near the nearby Cold Hill camp, in a dark sandy shale and in sandstone.

These localities seem well worth noting for record for the benefit of any specialists who may be interested and have the opportunity to work at this location.

HAROLD J. COOK

COLORADO MUSEUM OF NATURAL HISTORY

ZOOPHARMACOLOGY VERSUS PHYTOPHARMACOLOGY

I HAVE read with great satisfaction the appreciation of my contributions to phytopharmacology expressed by Professor Edwin H. Shaw, Jr., published in the first May number of SCIENCE, page 460; and I was especially interested in the writer's suggestion that

the idea of an antagonism between animals and plants could be extended to the subject of diseases and their treatment. Quoting from Dr. Shaw's communication, we read:

When we consider the infestations of an animal host with animal parasites, we have a markedly different picture. The host and parasite live together without any marked protective or offensive action on the part of either. When death occurs in these conditions, it is a result of the gradual destructive action of the parasite on some particular tissue of the host. The tapeworm, the liver fluke, the malarial plasmodium, the trypanosome, the filaria worm, the spirochete and the intestinal ameba may be taken as examples of this type of infesting organism. These organisms do not produce any great amount of toxins, and do not stimulate the host to form any great amount of protective substance.

I am writing the present note in order to corroborate with actual experimental data the conclusions he arrived at as a result of his lucid and logical reasoning. During the past year I have been investigating by my special phytopharmacological methods specimens of blood from two kinds of parasitic diseases. In one series of experiments, I have been examining the toxicity for plant protoplasm of blood from cases of malaria. Some of these specimens were obtained in the United States; other specimens, more particularly those from cases of virulent fever, were obtained through the courtesy of Professor R. N. Chopra, of the School of Tropical Medicine, Calcutta. The results of these experiments indicate that, as far as the phytopharmacological tests are concerned, malarial blood contains little or no toxin of any kind. Another series of experiments is at present being carried on by me in collaboration with Dr. O. R. McCoy, of the department of helminthology, Johns Hopkins University School of Hygiene and Public Health, on bloods obtained from dogs infested by the hookworm. These animals exhibit the picture of extreme anemia, and it was deemed desirable to inquire whether this anemia was of a pernicious type. Although these experiments are still in progress, the data already in hand indicate that the blood serum of dogs with hookworm shows no toxicity and behaves exactly like blood from human beings suffering from severe secondary anemias. These lines of investigation give a striking proof of the correctness of Dr. Shaw's reasoning in regard to infestations of an animal host with animal parasites.

DAVID I. MACHT

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THE FIRST ENGLISH POPULARIZER OF SCIENCE

PERHAPS other readers of SCIENCE might be as interested in examining Oliver Goldsmith's "A History of the Earth and Animated Nature" as was the writer, who recently, through Mr. Carter Bishop, of the English department of West Virginia University, was lent an old edition of this work. This particular edition, in two volumes of more than 1,000 large pages, was published in 1853 by A. Fullerton and Company. In this edition, more than fifty years later than the first edition, the editors claim to have corrected many errors of the original work.

In the publishers' advertisement at the beginning of the work they say that Goldsmith is the "first English writer who, by the inimitable graces of his style and manner, threw a charm over the subject which was new to the English reader, and the effect of which, in rendering the science of Natural History popular, has been great and extensive."

Besides the "inimitable graces of his style" the book is illustrated with numerous colored plates, some of which are really good. The classification, though of course antiquated, is in some cases not so much out of date as might be expected of a work written 150 years ago—Goldsmith died in 1774.

In the chapter on "The Crocodile and its Affinities" he mentions the four chief types of modern texts: the crocodile, the alligator, the cayman and the gavial. He tells many interesting things about the various members of the group, some of which details are undoubtedly true, some of which are doubtfully true and some of which—for example, the "open-bellied crocodile" that carries its young in an abdominal pouch—are obviously fiction.

Altogether the book is most interesting, if *not* to be recommended for general consumption by the non-scientific public.

ALBERT M. REESE

WEST VIRGINIA UNIVERSITY

QUOTATIONS

MEDICAL PATENTS

A REPORT has recently been issued by a Committee of the Association of British Chemical Manufacturers (London, November, 1929) suggesting alterations to the Patent Laws in respect of chemical inventions. Many of these suggestions will be welcomed by chemical workers as safeguarding their interests and those of the general public, and as simplifying procedure.

A large proportion of the report, however, is devoted to the question of "medical patents," *i.e.*, the patenting of chemical substances intended for the alleviation and cure of disease, and the committee make

certain recommendations of a revolutionary character to which I will refer again later. At the present time research work is in progress all over the world on the production of synthetic organic substances, often of very complex structure, and demanding the highest degree of chemical skill and knowledge for their production; one has only to recall the past successes of the chemist, such as aspirin, phenacetin, antipirin, novocain, stovain, salvarsan, "germanine," synthetic adrenaline, tryparsamide, and many others, to realize how deeply indebted is the medical profession to the work of the modern organic chemist. In some cases these products have been discovered as the result of researches by individual chemists working in conjunction with a pathologist; in other cases the results have been due to team work in which many chemists have been employed.

An examination of the patent literature indicates that until recently the patentees were predominantly German or Swiss firms, who, by obtaining patent protection for their discoveries, were able to develop them on suitable technical lines, bring them to the notice of the medical profession, and thus cover the heavy expenditure in time and money involved in such work by the sale of the successful patented article. Actually, however, there is no very great profit in such work, as the percentage of "bull's eyes" is very small and often only just enough to help to pay for the expenditure of ammunition involved. In fact, to continue the analogy, such work is rather like firing at a concealed target with a machine-gun; sooner or later an "inner" or a "bull" will be registered, but it necessarily involves a heavy expenditure of ammunition, and a firm or private investigator can afford to continue such investigations only if he is reasonably sure of some measure of protection when he actually succeeds in obtaining a direct hit.

When one considers the untold suffering which has been avoided by the use of, say, the synthetic local anaesthetics such as eucain or novocain, the hundreds of thousands of lives which have been saved by salvarsan (for venereal diseases), by acriflavine (for septic wounds), by germanine and tryparsamide (for sleeping sickness), it will be realized that humanity and the medical profession are under a very great debt to organic chemists. Recently, for instance, in French Congo, a case was quoted of a village of 126 natives of whom 83 were infected with sleeping sickness and doomed to a terrible and lingering death, while others were in a moribund condition: a year later, chiefly as the result of injections of tryparsamide, all these 83 patients were free from infection and fully convalescent.

Research work of this nature should obviously be encouraged in every way, but the report in question proposes a plan calculated to impede and discourage all further independent chemotherapeutic work in this country. It is seriously suggested that it is unethical for a chemist or medical man to receive any reward for his services in this direction, and that, if he is fortunate enough after months or years of work to discover a new curative agent, antiseptic, bactericide, or the like, and applies for patent protection, he shall be forthwith deprived of all his existing legal rights in this, as though he were an outlaw, and these rights shall be handed over to a new government official, the "Medical Patents Trustee," who will arrange for the manufacture of the product, settle terms of royalties, etc. Any such fees or royalties will be retained by the Medical Patents Trustee, who may, in his discretion, repay out-of-pocket expenses in connection with the investigation (and any one who has had to argue costs before a taxing master will realize the hopelessness of obtaining from any bureaucrat a sum anything near the actual cost), and any balance will be devoted to further research. In other words, the unhappy chemist must pay for all unsuccessful research from his own pocket, and when after long and arduous work he attains a successful result his success is to be snatched from him by a medical bureaucrat and devoted to purposes over which he has no control. "Heads I win, tails you lose." In other words, it is perfectly ethical for a chemist to devote his energies to the invention of new steels for armor plates and shells, of new poison gases or of new explosives for the destruction of his fellow men; but as soon as he is so unwise and so unworldly that he prefers to devote his skill towards the alleviation of human suffering, then he is at once to be penalized, and, for all the encouragement given him, he and his family may starve, while the manufacturers and merchants who market the product make their profit and the consultant who enhances his reputation by the successful cures with the new drug may charge whatever fees he feels right.

The whole scheme is fundamentally unjust, illogical, unworkable and contrary to the public interest, as instead of encouraging firms and individuals to carry on research in chemotherapy such work will inevitably slow down and cease except in so far as it may be carried out in government-controlled laboratories. There is, however, a very real danger that the weight of opinion of a vociferous, unenlightened and obscurantist portion of the medical profession may succeed in getting such an ill-advised scheme seriously considered and even smuggled through Parliament, and thereby set back the progress of chemotherapeutic research in this country for decades, while other nations with less distorted views continue to encourage

and assist chemists and medical research workers in their humane endeavors, for in this field no less than in others the laborer is worthy of his hire. No one familiar with the situation in this country in the early days of the war can fail to understand the seriousness of the present attack upon chemotherapeutic research.—Frederick A. Mason, College of Technology, Manchester. *The London Times.*

SOCIETIES AND MEETINGS

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE twenty-ninth annual meeting of the North Carolina Academy of Science was held at Duke University, Durham, on May 9 and 10. Papers were presented before the general section of the academy on Friday morning and afternoon. Following the presentation of papers and the business meeting on Friday afternoon, Duke University served the academy a picnic supper on the new Duke campus. Friday evening the retiring president, Dr. J. B. Derieux, professor of physics at State College, gave his presidential address on "The Corpuscular Theory of Radiation and the Wave Theory of Matter." After this an informal reception was given the academy by Duke University. Saturday morning the academy met in the following sections: General section, chemical section, mathematics section and physics section. Seventy-seven papers and five exhibits were on the program. (Abstracts of most of them and complete papers of several will appear in an early number of the *Journal of the Elisha Mitchell Scientific Society.*)

The executive committee reported the election of thirty-four new members during the year and the reinstatement of four former members. Dr. F. P. Venable, professor of chemistry of the University of North Carolina, was made an honorary life member as a token of appreciation for his services to the academy, to science and to his state. Dr. Venable has been a member of the academy since the year of its origin, 1902, and is this year retiring from active duty after fifty years' service at the University of North Carolina (professor of chemistry, 1880–1900; president, 1900–1914; professor of chemistry, 1914–1930). Two hundred and twenty-eight registered at the meeting.

Mr. Calhoun Pruitt, a student of the Monroe High School, was declared the winner of the High School Science Prize, a silver loving cup, for the best essay presented by a high-school student. Essays for 1930 were confined to the fields of chemistry and physics.

The officers elected for the year 1930–31 were:

GENERAL ACADEMY

President, W. F. Prouty, University of North Carolina.
Vice-president, P. G. Ginnings, Greensboro College.
Secretary and treasurer, H. R. Totten, University of North Carolina.
Executive committee, the above officers and F. A. Wolf, Duke University; Bert Cunningham, Duke University; W. L. Porter, Davidson College.
Representative to the A. A. A. S., W. C. Coker, University of North Carolina.

CHEMICAL SECTION

Chairman, T. A. Bigelow, Duke University.
Vice-chairman, A. J. Wilson, State College.
Secretary-treasurer, H. D. Crawford, University of North Carolina.
Councilor, L. G. Willis, State College.

MATHEMATICS SECTION

Chairman, W. W. Elliott, Duke University.
Secretary, E. L. Mackie, University of North Carolina.

PHYSICS SECTION

Chairman, A. A. Dixon, State College.
Secretary, W. E. Speas, Wake Forest College.

The thirtieth annual meeting of the North Carolina Academy of Science will be held at State College, Raleigh, in the spring of 1930.

H. R. TOTTEN,
Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A BELT PAPER KYMOGRAPH WITH A THREE SPEED GEAR SHIFT

THE recent appearance in SCIENCE[1] of an article describing a commercially built kymograph with a multirange gear shifting device has prompted the writer to describe a kymograph provided with a speed reducer and a gear shifting device which was built by junior and senior college students in mechanical engineering.

For more than a decade the writer has been interested in belt paper kymographs and has frequently studied published diagrams as well as observed those in operation. Therefore, about four years ago when called upon to design an electrically driven belt paper kymograph it was thought best to construct the machine as herein described.

[1] Porter, Roy and Vianey, "An Electric Kymograph," SCIENCE, 71: 41, January 10, 1930.

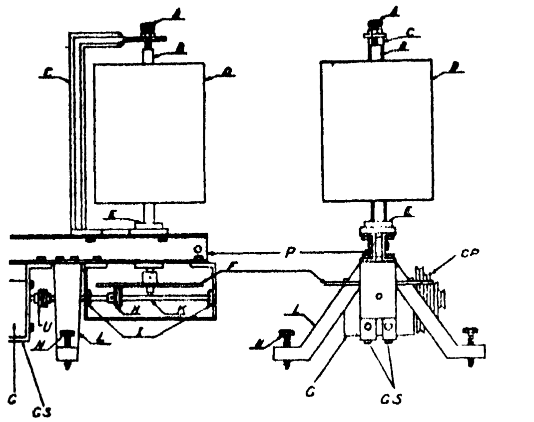

FIG. 1

The frame consisted of two 1 x 2 inch channel irons, Fig. 1, *P*, placed in parallel position and supported by cast-iron legs. To this frame was firmly bolted the head drum bracket, *C;* but the tail drum bracket was arranged so that it could be moved back and forth upon the frame and firmly fixed at any desired position by means of a wing nut. These drum brackets were made sufficiently large that they would accommodate an 8 x 10 drum or two 6 x 6 Harvard drums. The general arrangement of supporting legs, *L;* head drum, *D;* friction drive, *H* and *F*, and the gear box *G* may be noted in Fig. 1, which shows both side and end views of the chief mechanical parts.

The friction drive was chosen because of its simplicity and elasticity. A 7 inch brass disk, Fig. 1, *F*, mounted upon the vertical drum shaft *B* just below the frame is caused to rotate by friction of a leather or fiber wheel *H* which is mounted upon the horizontal power shaft *K*. After learning that the friction disk must be slightly rough and that the leather wheel should be at least two inches in diameter no further trouble was experienced. The power shaft *K* terminates distally in the universal joint *U* by which it is attached to the output shaft of the gear box. As the first kymograph operated satisfactorily still others were made with but slight modifications.

Since these kymographs were driven by a 1/20 h.p. motor operating at 1125 r.p.m., it was necessary to reduce the speed 2,000 times between the motor and the friction drive. In the early model this was accomplished by means of worm gears alone. Learning that the flexibility of the machine was reduced to zero the writer set about to find some type of gearing which would allow rapid changes of speed as well as increase the general flexibility of the machine as a whole. This was accomplished by means of a gear box shown in Fig. 2, which not only contains the reduction gears but also a three speed gear shifting device as well. In Fig. 2, *A* represents a 1-1 set of spiral gears; *C*, a 50-1 worm gear set, and *H* a 20-1 worm gear set. The various other gears, *B, D, E, F, G, I* and *J*, are all of 24 pitch, but *B* is only one half the size of *D*, which in turn is four times the size of *E*. *D* has 48 teeth; *F* and *G* both have 20 teeth.

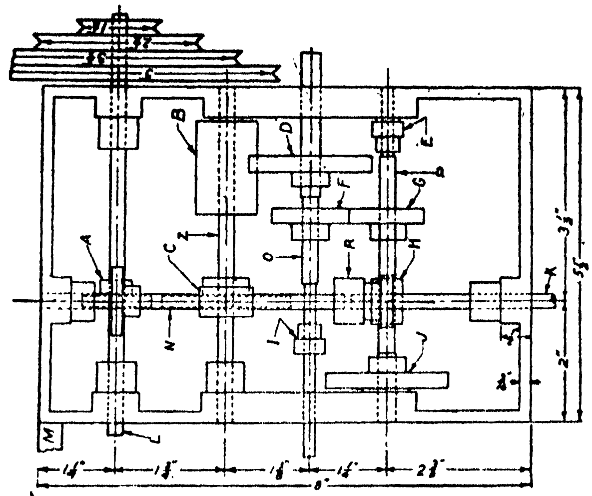

FIG. 2

Therefore, as the wheels stand in Fig. 2, intermediate position, the speed reduction is 2,000–1. If pressure were put upon the right end of the movable shaft *O*, the wheels *F* and *G* would be thrown away from each other into a neutral position. Further pressure would cause the wheels *D* and *E* to engage and then the speed would be reduced only 500–1, high speed. On the other hand, if pressure were applied to the left end of shaft *O* the wheels *F* and *G* would be thrown out of contact and into a neutral position, but still further pressure would cause wheels *I* and *J* to mesh and the speed would be reduced 8,000–1, low speed, since *I* and *J* are the reverse of *D* and *E*. The lever for shifting gears and the devices necessary

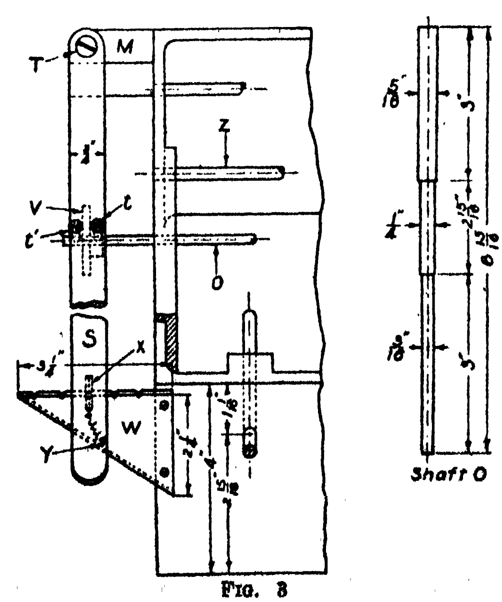

FIG. 3

for retaining the gears in the position desired are shown in Fig. 3. The use of a four stage cone pulley adds further flexibility.

All the gears used, except wheel *B*, may be readily secured from nearly any machinery or model maker's supply house. Wheel *B* has 24 teeth at 24 pitch with ¾ inch hole and 1½ inch face. This wheel was obtained from the Boston Gear Works.

SUMMARY

1. Herein has been described and illustrated a belt paper kymograph, electrically driven, and provided with a three speed gear shift.

2. By the use of this gear shift the operator may instantaneously change the speed of his paper from intermediate to high speed which is four times faster or to low speed which is four times slower.

3. By the arrangement of gears here shown no clutch or clutch lever is needed, and the operator may readily alter the speed by the use of either hand.

4. Although this gear box may appear somewhat complicated and difficult to construct it was built by junior and senior college students in mechanical engineering.

ALVAH R. MCLAUGHLIN

UNIVERSITY OF WYOMING

SPECIAL ARTICLES

SURFACE TENSION BY THE RING METHOD

SINCE surface tension determinations are made frequently by chemists and physicists, and especially by biologists and in the industries, it is important that the quantity measured shall be the surface tension itself and not some other force. Of all the methods which are applied the determination of the pull on a ring is the most often used, as is evidenced by the fact that in one biological laboratory sixty thousand such determinations were made in a period of five years. The wide-spread popularity of this method is probably due to the ease with which a ring of platinum or platinum-iridium may be cleaned, and the resultant rapidity of the measurement, since all that apparently needs to be done is to put the ring in contact with the surface of a liquid, and to determine the force needed to pull it away from the surface.

Although what has been called the "ring method" has been so widely applied, it is a surprising fact that *until four years ago there was no ring method for the measurement of surface tension,* since all that was determined was the pull on the ring, which is related to the surface tension in a way that was before that time unknown. Thus in "International Critical Tables" nine experimental methods for such measurements are listed, but a ring method is not included, since the procedure which had been designated by this term did not supply even one single measured value of surface tension for these tables.

The failure of the ring procedure was due to the fact that the theory had not been developed with sufficient completeness, though an excellent beginning had been made by Cantor,[1] Lohnstein,[2] Lenard,[3] Tichanowsky,[4] MacDougall[5] and others. Since, however, their equations are not extremely simple, and moreover apply only to rings of such dimensions as make them impractical for use, it was customary to neglect their theory, and to calculate the surface tension from the entirely incorrect equation

$$\gamma = \frac{P}{4\pi R} \quad \text{(incorrect)} \qquad (1)$$

in which P is the maximum pull in dynes as determined by a balance, R is the mean radius of the circular ring and γ is the surface tension in dynes per centimeter.

In 1926 Harkins, Young and Cheng[6] demonstrated that a correct value of the surface tension is given by the expression

$$\gamma = \frac{P}{4\pi R} \times F \qquad (2)$$

Since $P = Mg$, in which M is the mass in grams indicated by the balance, and g is the gravitational acceleration, this may be written

$$\gamma = \frac{Mg}{4\pi R} \times F \qquad (3)$$

That the equation (1) generally used is entirely incorrect and does not give the surface tension at all is shown by the fact that in our experiments the value of the factor by which this must be multiplied to give the surface tension has varied from 0.72 to 1.45, or it exhibits a variation of 100 per cent. The most harmful and absurd fallacy in this connection is the statement which appears so often in connection with this incorrect equation: "It may be true that it does not give the proper absolute values, but of course it gives the correct relative magnitudes." This is entirely untrue,

[1] Cantor, *Wied. Ann.*, 47: 399, 1892.
[2] Lohnstein, *Ann. Physik*, 25: 815, 1908.
[3] Lenard, *ibid.*, 74: 395, 1924.
[4] Tichanowsky, *Physik. Z.*, 25: 300, 1924; 26: 523, 1925.
[5] MacDougall, SCIENCE, 62: 333, 1926.
[6] Harkins, Young and Cheng, SCIENCE, 64: 333, 1926.

since the factor (F) is, as has been stated, highly variable.

The values of F are given in Fig. 1. It may be seen that the value depends on the ratio of the radius

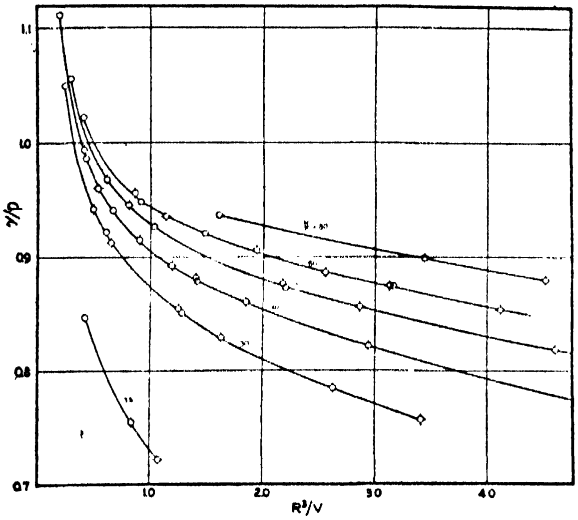

Fig. 1. Correction Factors (F) or $\frac{\gamma}{p}$ for the Ring Method for Surface Tension.

(R) of the ring to that of the circular wire (r) from which it is made, and also on the ratio of the cube of the radius of the ring to the volume of liquid upheld by the ring (R^3/V). This volume is equal to the maximum pull (M) on the ring in grams, divided by the density (D) of the liquid phase, or more exactly to (M/D–d), in which D is the density of the liquid of higher density, and d that of the fluid (liquid or gas) of lower density. The number on the curve gives the value of R/r, and the abscissas the values of R^3/V. Both of these are known in any determination, and the unknown value of F is the proper ordinate. An extensive table of the values is given in the May, 1930, number of the *Journal of the American Chemical Society,* pages 1759 to 1770.

Dorsey[7] has recently suggested that many workers, particularly those who use the du Noüy tensiometer, may be unknowingly measuring the pull of a film of liquid on the ring, rather than the maximum pull (P). The pull on the ring varies with the height (H) of the ring above the plane portion of the surface. For example, ring 10 as used by us has a radius R of 0.6366 cm, while its wire has a radius (r) of 0.01570, so the value of R/r is 40.55. Fig. 2 shows that the maximum pull of 0.5912 grams is attained when the height (H) is 0.302 cm, and that the pull is smaller for either greater or smaller heights. However, it is difficult to increase the height above that for the maximum pull, so what is measured with the ordinary technique is the

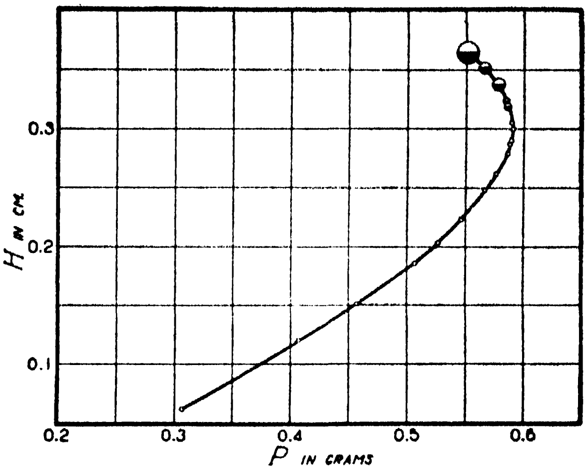

Fig. 2. Variation of the Pull on a Ring with its Height above the Surface of a Liquid.

maximum pull, at least if a chainomatic balance is used for the measurement.

Fig. 3 shows the flask used to contain the liquid whose surface tension is to be measured. The surface

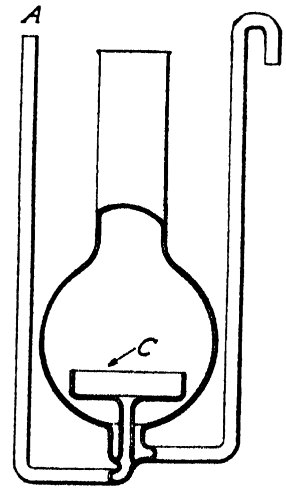

Fig. 3. Flask for the Liquid used in Determining Surface Tension by the Ring Method.

of the liquid is held at C, and the diameter of the surface should be in general 7.5 cm or larger. The use of such small quantities of liquid as to give a much smaller surface invalidates the measurement. Thus the ordinary custom of using small evaporating dishes for this purpose should be discontinued. In order to give a clean surface, the surface is caused to overflow at C before the surface tension is measured. This is particularly important with water.

Fig. 4 gives the apparatus as a whole. The ring is lifted away from the surface by raising the balance by a mechanism which operates so smoothly that it transmits almost no vibration to the beam of the balance. This obviates lowering the vessel that contains the

[7] Dorsey, Science, 69: 187, 1929.

liquid, which sets up vibrations in the surface, and as a result the ring detaches at a pull less than the maximum.

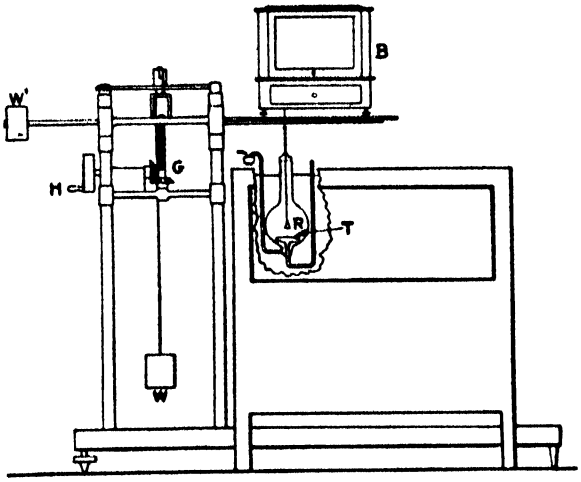

FIG. 4. Apparatus for Determining Surface Tension by the Ring Method.

For accurate work it is important that the ring be kept level. Fig. 5 illustrates the error due to tipping

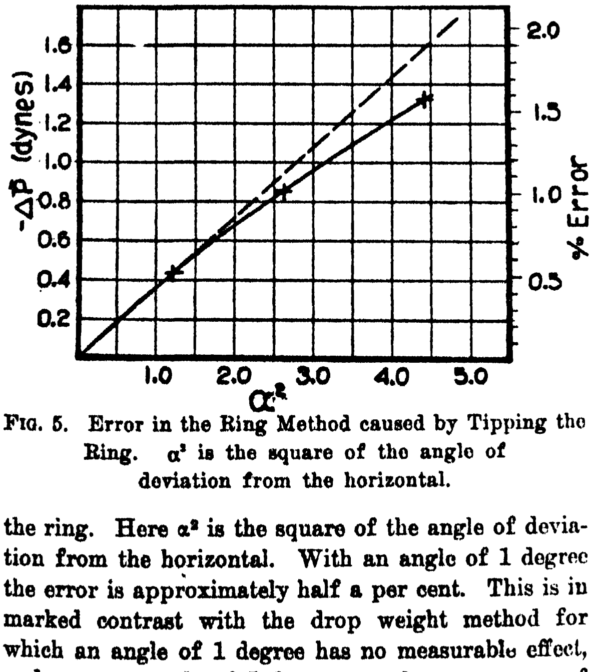

FIG. 5. Error in the Ring Method caused by Tipping the Ring. α^2 is the square of the angle of deviation from the horizontal.

the ring. Here α^2 is the square of the angle of deviation from the horizontal. With an angle of 1 degree the error is approximately half a per cent. This is in marked contrast with the drop weight method for which an angle of 1 degree has no measurable effect, and even an angle of 5 degrees produces an error of only 0.04 per cent.

It should be kept in mind that while the drop weight method is independent of the angle of contact between the liquid and the solid of the tip, provided proper tips are used, the ring method is highly dependent on the angle, and should be used only when it is zero.

The four most widely used methods for the determination of surface tension are: (1) capillary height, (2) drop weight, (3) ring and (4) bubble pressure. Of these the capillary height and drop weight methods are the most accurate, and the bubble pressure method is the least accurate. With pure liquids the methods are accurate under the best condition to the following extent: capillary height, ± 0.05 per cent.; drop weight, ± 0.1 per cent.; ring, ± 0.25 per cent., and bubble pressure, ± 1.5 per cent. However, with certain solutions, especially biological liquids, the drop weight method is much more accurate than the determination of the capillary height.

The large error of the bubble pressure method is due to the fact that those who use it most do not determine the maximum pressure, which the theory demands, but only a mean pressure, which is related in an unknown way to the surface tension. Dr. T. F. Young is now engaged in a critical study of the method, and it seems probable that its accuracy will be greatly increased.

Of the four methods only that of the capillary height has been an absolute method. However, Drs. B. B. and H. Z. Freud have recently published a communication[8] in which they present a satisfactory theory, which gives the same results as our experiments. Thus the ring procedure becomes an absolute method for the determination of surface tension. The determination of the bubble pressure would give a third absolute method if the procedure were carried out in a way demanded by the theory, but, unfortunately, most of those who use it do not meet the conditions of the theory.

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THE REVIVAL OF COMATOSE ADRENALECTOMIZED CATS WITH AN EXTRACT OF THE SUPRARENAL CORTEX

IN previous brief reports published in this journal[1] the writers described the preparation of an active extract of the suprarenal cortex of beef and its effect upon the life-span of bilaterally adrenalectomized cats. It was demonstrated that extract-treated animals survive in normal health indefinitely and when the extract treatment is discontinued death from adrenal insufficiency results within a short time. To date we have not had an adrenalectomized animal present any symptoms of adrenal insufficiency while receiving treatment. At the end of one hundred days of treatment (an arbitrarily selected period, after which the extract is discontinued) the animals can not be distinguished from normal cats. Mention was also made in the earlier publications of the fact that non-treated adrenalectomized cats showing early

[8] SCIENCE, 71: 345, 1930.
[1] SCIENCE, 71: 321, and 71: 489, 1930.

symptoms of adrenal insufficiency could be returned to normal by administering extract.

Recently we have completed a series of experiments in which the extract was tested on comatose animals prostrate and on the verge of death from adrenal insufficiency. The extract employed is a modification of the one previously described and is very low in adrenalin and solid content.

The cats were bilaterally adrenalectomized and allowed to develop very severe adrenal insufficiency symptoms. At the time of first injection of extract they were prostrate and unable to stand on their feet or move about, and so weak that if placed on their feet they promptly collapsed. The skin was cold and clammy and the rectal temperature down to 95°. The rectal temperature of normal or unilateral operated cats ranges from 101.4 to 102°. Adrenalectomized cats presenting the symptoms just described live but a few hours and death may occur at any moment.

By repeated injections of our purest preparations we have been able to revive such animals and return them to normal condition and to keep them in perfect health by daily injections. The body temperature, blood picture, appetite and strength return to normal.

It is a striking experience to one working with the animals to take a comatose cat with death imminent from adrenal insufficiency and by a few injections to revive it so that within seventy hours it has completely recovered and is running and playing about the laboratory apparently none the worse for its hazardous experience.

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THE HORMONE OF THE ADRENAL CORTEX

IN 1927[1] we first published a method for producing an extract of the adrenal cortex which would prolong the lives of totally adrenalectomized cats. Saturation of an acid extract with NaCl forms a precipitate which when dissolved and injected produces this effect. Heating the extract to 80° C. for five minutes destroys the active substance. The addition of ethyl alcohol to make 80 per cent. precipitates the proteins coagulable by heat and nitric acid but does not destroy the hormone.

We have long realized that the method of separating the hormone by salting out is unsatisfactory as a means of concentrating the active substance because with each precipitation so much is lost. We therefore have been working for some time with organic solvents.

The simplest method of preparing a concentrated extract of the hormone is to extract the cortex with ethyl ether. Removal of the ether by vacuum distillation is followed by extraction of the residue with 80 per cent. ethyl alcohol. The alcohol is removed *in vacuo* and the residue taken up with water to make the desired concentration.

Adrenalectomized cats treated with such an extract can be maintained in good condition for an indefinite period. Such cats allowed to go without extract until so weak that they can not sit up and appear near death have been revived by injections of this extract.

One cat had gone so far that she was lying prostrated, breathing rapidly and constantly twitching in various muscles of the body. She was expected to die before we could use remedial measures. Within an hour after injection of cortical extract the twitching ceased and the breathing became normal. Seventy minutes after injection she was sitting up. In ninety minutes she had recovered her strength and was eating.

In 1928[2] we named this hormone cortin. It is the substance essential to life found in the adrenal cortex.

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[1] F. A. Hartman, C. G. MacArthur and W. E. Hartman, *Proc. Soc. Exper. Biol. and Med.*, 25: 69, 1927.

[2] F. A. Hartman, K. A. Brownell, W. E. Hartman, G. A. Dean and C. G. MacArthur, *Am. Jour. Physiol.*, 86: 353, 1928.

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THE ORIGIN, GROWTH AND SIGNIFICANCE OF THE MENTAL HYGIENE MOVEMENT[1]

By Dr. WILLIAM A. WHITE

SUPERINTENDENT OF ST. ELIZABETH'S HOSPITAL, WASHINGTON, D. C.

OF the many mixed feelings with which I greet you, that which is uppermost at the moment is that at some day in the future, perhaps not far distant, those who follow us will look back upon this occasion and realize that it was a historic moment in the development of the movement for mental health. I myself personally have faith that this is so, and I have no doubt that many of you also have that same faith. Certainly those of you who have come from far distant lands must feel that this cause which we represent is one of no small moment.

It is fitting that this congress should have been so arranged as to open on this day, the sixth of May, which is the twenty-second anniversary of the formation of the first mental hygiene society in the world—the Connecticut Society for Mental Hygiene, about the origin of which you have already heard. It is significant that the same group that was responsible for this Connecticut society a few months later—namely, in February of the following year—brought into existence the National Committee for Mental Hygiene, and thus almost at once gave the mental hygiene movement a national complexion. And now at the end of these twenty-two years mental health has become of international significance and this congress is the outstanding indication of the spread of the mental hygiene movement over the face of the earth.

As you have just heard Mr. Beers say, this afternoon the Organizing Committee of the International Congress had its meeting in the Academy of Sciences Building and created an International Committee for Mental Hygiene, thus making this international move-

[1] Presidential address delivered at the First International Congress on Mental Hygiene, Washington, D. C., May 6, 1930.

ment permanent, crystallizing it in the form of an organization and insuring future international congresses at periods of five years, with intermediate meetings of smaller dimensions at such times and places as circumstances might indicate.

You have already seen and heard Mr. Beers. I am, however, moved to say in addition to what you have already heard, and perhaps to add to what you may already know, that it was the mind of Mr. Beers that originally conceived the mental hygiene movement and visioned its possibilities. For a hundred years patients had been leaving our public institutions for mental diseases with a sense that if they had recovered, they did not owe it to the way they had been treated. In numerous instances they must have felt outraged at the experiences they looked back upon—at the cruelty, the callousness, the lack of sympathy with which they had been confronted during their confinement. But it was given to only one man who had had such experiences to have these memories of his treatment strike deep to the very core of his being, and there, instead of rankling and making him resentful, take root and grow and produce the fruit that is now the mental hygiene movement. He had been outraged as these others had been, but by some strange alchemy of his mind these outrages did not have the same effect. They stirred him to creative activity. They stimulated him to find the reasons for it all, to try to correct what he felt, not as personal animosity and antagonism to him, but as ignorance and stupidity, to try to see that those who followed him should be saved such experiences as he had passed through. This man, the genius of whose mind among a million saw opportunity where no one else had seen it for a century, this man, as you well know, is Mr. Clifford W. Beers; and that you may realize the full measure of his great work, remember that not only has he been willing these twenty years to devote his time, strength, everything that he had to the success of the mental hygiene movement, but that he has been willing to strip his soul and tell his experiences to the world in that wonderful book of his, "A Mind That Found Itself." It is because of his willingness to do this that I am able to speak as I do about him to-night. The movement as it stands to-day owes him a debt that it can never pay. Who can predict the extent to which future generations may in turn be indebted for what he has given the world, the suffering that will be obviated, the understanding and intelligent treatment that will be encouraged.

My friends, there are one million young people walking the streets of the United States to-day who, if the statisticians are able to tell us the facts about the future, are necessarily doomed to spend some of their time before they die in institutions for mental disease. It is only by appreciating such staggering figures that it is possible to understand the necessity for this movement throughout the world.

The way in which the mental hygiene movement originally came into being seems to me of the utmost significance. It was not the outgrowth of any philosophy started by a group who were bound to prove that the tenets of that philosophy were sound. It was infinitely more simple. Its objective—and its sole objective except for some broader formulations regarding prevention and research that appeared even in its first statements—was in its earliest days the improvement of the care of the so-called "insane." Mr. Beers was convinced by personal experience that this care was not what it should be, that its defects were due to ignorance largely, to lack of understanding the mental patient and of proper standards of care in institutions, and he set about in a constructive way to correct the evils as he saw them. As you see, a perfectly simple procedure. Certain things were wrong. What could be done to improve them? Here was a program with which no one could find fault. As soon as presented, it necessarily found agreement on all hands. And so the movement was launched in this way. The attitude of mind that animated those who were originally involved was one with which we are perfectly familiar. It has been the attitude through the ages of the physician. He sees things that produce unhappiness and suffering and he tries to correct them. He does not wait until all the scientific and philosophical questions that could be raised surrounding the particular situation are solved, nor does he alter his treatment according to whether he considers his various types of patient more or less worth while. Mental hygiene did not stop to solve the metaphysical, philosophical and theological problems that have always been associated with the study of the mind. It did not seriously consider such questions as the freedom of the will or the relation of body and mind or the moral factors that were involved in mental illness, but accepted man just as it found him, with his hates and loves, his hopes, fears, wishes, aspirations and ideals, and tried to find a better solution for his difficulties than he had been able to. It is precisely the attitude of the surgeon at the operating table to whom is brought a man with a bullet wound. He does not stop to inquire how the wound was received, whether in the commission of a crime or in the defense of his home, but proceeds at once to see how matters can be made better. He feels it to be his duty to give the best he has of his skill then and there to that particular patient without qualification. That is what the practice of medicine means to him and has meant down the ages. Back of this way of going at things lies the tacit assumption

that human life is in itself valuable, that it is worth while to save it and that the way in which it is lived can often be improved with a little help.

Naturally it was not long until, as the result of the application of such methods to the mentally ill, it became quite obvious that the field of possibilities was considerably larger, and the program that had been found useful for patients in the public institutions for mental disease was subsequently modified and adapted to other types of individuals, such as defectives and criminals. The net result I do not need to tell you. Institutions for the mentally ill have been inestimably benefited by the mental hygiene movement, institutions for defectives probably to a less extent and prisons perhaps the least of all, but active measures are being taken to bring to these people also some measure of relief.

While matters were progressing along these lines the concept of mental illness was being enlarged to include a great many things besides the types that we were accustomed to see in public institutions. Not only were the minor psychoses and the neuroses included, but all forms of social maladjustment and even of unhappiness were seen to have mechanisms quite the same as the more serious conditions with which we were more familiar. The mental diseases of the public institutions were obviously end products of many years of bad mental hygiene, and so the question at once arose as to the possibility of cutting off the source of mental disease at its origin by getting back to the beginnings and correcting the difficulties at that point. So there developed the application of mental hygiene to the school and to the educational system. In the meantime various forms of maladjustment, in occupation particularly, had received attention, and industry was becoming interested in trying to effect a happier relation between the employee and his job and to prevent the great cost incident to a large turnover in industrial establishments. The army and the navy realized the importance of preventive methods and undertook the earlier recognition of mental defect and disorder, with a view to saving both the military establishment and the individual unnecessary expenditures of time and effort.

All these things and many more have happened with bewildering rapidity, and it has been next to impossible to keep up with the demands that have been made upon mental hygiene from all these various sources. In order to understand their significance more fully, it is necessary to remember that about the same time that the mental hygiene movement started, a very great change took place in the field of psychiatry. To the end of the nineteenth century mental disease had remained at the descriptive stage of development. It was still collecting and classifying its material. But with the beginning of the present century there came an effort to understand the meaning and significance of this material. Psychiatry attempted to find the causes, the tendencies, that lay back of the mental symptoms and that would, therefore, serve to explain their meanings, and in doing so it developed a technique of procedure that was analytic in type and served, as it were, the purpose of dissecting out the various psychological tendencies from one another so that they could be seen more nearly in pure culture and thus understood. This technique resulted in the development of an entirely new psychology based largely upon the emotions and upon those tendencies which lie beneath the threshold of consciousness, rather than upon the intelligence and those things of which we are clearly aware, which were more particularly stressed in the last century. Thus has grown up by analogy an anatomy and a physiology of the mind which disclose quite as multitudinous and complicated a set of structures and functions as we are all familiar with in the body. This new outlook, pregnant with such infinite possibilities, proved an enormous stimulus and has had much to do with vitalizing the movement for mental hygiene, which has taken over here and there as it could the various concepts from psychotherapy, psychopathology and psychiatry that it found useful.

While the spirit that animates the mental hygiene movement is in essence that of the physician, still methods of dealing with mental disorder and ways of thinking about it are in many respects quite different from those to which the physician has heretofore been accustomed. The several organs of the body have a different value from that which they had in the days when medicine was altogether the medicine of the body. Physical health was then the objective, even sometimes the physical integrity of a particular organ, in the mind of the specialist, whereas to-day we see the individual, not from the point of view of the integrity of his several organs, but as a social unit; the main significance of his several organs has shifted and, instead of presenting ends in themselves, they have importance in the scheme of the individual's life because of their ability to serve him, their capacity or incapacity to be of assistance in helping him bring to pass his ideals.

In all these ways mental hygiene has developed, and finally we see the movement separating out into three methods of procedure: first and earliest, a therapeutics based upon the control of the stimuli to which the organism is subjected by its environment; secondly, a psychotherapeutics that endeavored to change the individual from within, and thirdly, prophylaxis as applied to this great problem in preventive medicine.

Of these three methods the first two are therapeutic and the third is preventive, and as time goes on the preventive becomes the most important because, as I have indicated, mental disease, when finally developed, has already had several years of incubation, and it is obviously economically more worth while to try to prevent its origin than to cure it after it has become a serious problem. Particularly does the preventive problem loom as important when we learn, as we have in this country, that mental hospitals, or at least the number of beds in mental hospitals, are increasing more rapidly than the beds in all other types of hospitals combined. The significance, therefore, of mental hygiene as a public health problem is second, at the present time, to none other in medicine.

Finally, however, mental hygiene has developed a positive aspect which bids fair, as I see it, to be its outstanding feature in the course of its future development. The problems of contagious and infectious and epidemic diseases, whereas they have not all been solved, are all in process of solution along with many others, and the net result is that the average length of life has been very greatly increased. Obviously it becomes of increasing significance that these lives that are to continue for so many more years should afford some measure of comfort to their possessors and be of some social value. Mental hygiene is on this account alone more important than ever before, and its significance can be seen to be gradually changing from one of the simple prevention of mental disease, which is a negative program, to the positive attitude of endeavoring to find ways and means for people to live their lives at their best. Medicine has long enough maintained as ideals freedom from disease and the putting off of death. It is time that these were replaced by ideals of living, of actual creative accomplishment. The art of living must replace the avoidance of death as a prime objective, and if it ever does succeed in replacing it in any marked degree, it will be found that it has succeeded better in avoiding death than the old methods that had that particular objective as their principal goal. Health is a positive, not a negative concept.

This change in the significance of the desirability of health which the mental hygiene point of view has brought about is a matter of the utmost importance. It means no less than the pointing of all educational problems toward man's own welfare and best interests. It means the revaluation of biological laws in terms of their human significance, and the understanding of the significance of emergent evolution in its application to psychological functions. It involves almost a complete about-face from the educational methods of the last century and opens up untold vistas of possibilities for the future. The future of the evolution of man, it would seem, will be almost wholly confined to the evolution of his mind, and so far as we are able to determine from what we know of the mind and from our studies of the brain, the capacity for development of man's mind is to all intents and purposes infinite, and so with the new impetus from these new view-points of mental hygiene it is fair to assume that at some future date man may acquire as much knowledge of himself and control over himself as he has knowledge and control of his environment at the present time. A contemplation of such possibilities offers attractive opportunities for speculation which each may indulge according to his bent. But I for one verily believe that this century, which developed the world war catastrophe in its early years and led many to think that civilization itself was threatened, will ultimately prove to be the greatest of all centuries in accomplishments, particularly in the understanding of man by himself and in consequence a greater control of his destiny as it is worked out in the newly developed art of living.

I have indicated in the briefest possible way the simple beginnings of the mental hygiene movement and something of the course it has pursued in its development. It has finally come to branch out in so many directions that it is exceedingly difficult to gather them all into one all-enveloping concept. On the one hand, general medicine is appreciating more and more the psychological factors in disease. Some three years ago here in Washington at the meeting of the American Medical Association, the outstanding and most representative medical society in this country, its largest section on the practice of medicine devoted an entire afternoon to the subject of the emotional factors in disease, and I heard the internist and the cardiologist and other specialists tell of the large proportion of patients that they saw in their offices in whom they could find no disorder of the body. On the other hand, the social sciences are beginning to appreciate the psychological factors with which they have to deal. Social workers of various sorts are realizing more and more the significance of these factors. The criminologists are appreciating that radical differences are taking place in the concept of the nature and the significance of crime and of the best ways of treating criminals, and that these changes are taking place as a result of that sort of knowledge of the criminal that has been obtained through psychological means. The mental hygiene factor is evident in all directions, in medical problems and in social problems, not only in those that I have mentioned, but in many others. What are the mental hygiene factors, for example, that are involved in the multitudinous problems comprised in marital incompatibility, in venereal prophylaxis, in birth control,

in prostitution, in sterilization, in alcoholism and drug addiction, in the problems of old age and in chronic diseases such as tuberculosis and cancer, to cite only a few? What is the mental hygiene basis for such practical matters as the censorship of literature, of art, of the stage and of the movies? And in myriads of other directions how are we going to get any guidance unless we appreciate the fundamental psychological principles that lie at the basis of all these questions? And, finally, I am reminded that one of the most recent requests that has crossed my desk was a request to recommend a speaker to a distinguished group, meeting in the near future, who could discuss for them the bearings of mental hygiene on international relations. Surely the gamut is sufficiently extensive. And if, as the Greek philosopher said, "Man is the measure of all things," it might be added that that part of man which measures is his mind. If twenty-two years ago some one had said of Mr. Beers's prophecy of an international movement that it was impossible, every one would have believed him, but there is one factuality of the human mind to which the psychologists have paid very little attention, and that is the factuality of bringing to pass the impossible. In this particular instance, Mr. Beers's impossible prophecy has come to pass.

In this brief survey I have indicated some of the outstanding points in the development of the mental hygiene movement, how in the first instance the trials and tribulations of Mr. Beers were converted by the alchemy of his mind into the mental hygiene idea and how finally this has developed in every direction until it has reached international proportions. I have briefly indicated how the thought of the physician has been gradually changed by the introduction of the concept of mental health, and I would add only a few more words along this line in closing, for I believe that the most significant change that mental hygiene is going to effect in the future will be a change in our concept of values as applied to human beings. I have indicated that the highest ideals that medicine had reached in the last century were the prevention of disease and the avoidance of death. These ideals, when applied in the mental field, were expressed in the well-known dictum, "A sound mind in a sound body." If, however, as I believe, living in order to avoid dying presents very little that is either worth while or stimulating as an ideal, so the concept of the sound mind in the sound body falls equally short of the truth, and in the same, namely, a negative, direction. The thought that I would like you to take away from the few words that I have said is that mental hygiene presents a positive program for life well lived, for mental health because of its values and not because of what it avoids. The value of life is measured by what we become, and so by the nature of the influences we radiate in our living. Life's values, from the standpoint of mental health, are not expressed in terms of the chemistry of nutrition or the integrity of the heart muscle or of any organ, but in terms of character, of man as a social being, of those effects which he produces on those about him, the enthusiasms he stimulates, that go reverberating down the ages translated by the personalities that trace back to the original source. This is a tangible form of immortality toward which every one may strive with some show of success, and in the striving get out of life the most there is in it for him. Perhaps I can express this ideal no better than in the words of Plato, who said over two thousand years ago: "My belief is, not that a good body will of its own excellence make the soul good, but on the contrary that a good soul will by its excellence render the body as perfect as it can be."

PERIODICALS FOR ELECTRICAL ENGINEERS

By Professor J. K. McNEELY AND C. D. CROSNO

IOWA STATE COLLEGE

THREE items of importance in the qualifications of a department for granting the degree of doctor of philosophy are a competent staff, adequate library facilities and funds and equipment. The lack of any one of the three will seriously interfere with thorough research work and render futile the research work of the staff and of the advanced graduate students.

This paper is concerned with the library facilities. It was thought desirable that the research publications at Iowa State College be checked over to ascertain the deficiencies existing. The question at once arose as to the standard to be used in making a list of the periodicals which should be available.

It was found that similar studies had already been made in the fields of chemistry[1] and mathematics.[2]

After some study, it was decided to count the references to periodicals in the following journals for the period from January, 1925, to June, 1929, inclusive.

[1] P. L. K. Gross and E. M. Gross, "College Libraries and Chemical Education," SCIENCE, 66: 385, 1927.

[2] Edward S. Allen, "Periodicals for Mathematicians," SCIENCE, 70: 592, 1929.

Table I gives the number of references in each of these journals for this period.

TABLE I

Seven Journals Used

	Number of references
American Institute of Electrical Engineers (*Transactions*)	2,994
Archiv für Elektrotechnik	2,122
Electric Journal	187
Elektrotechnische Zeitschrift	4,602
Franklin Institute, *Journal*	446
Institution of Electrical Engineers, *Journal*	2,174
Revue Générale de l'Electricité	5,466
Total	17,991

It will be noted that the list contains three American, one English, two German publications, and one French publication. The result is that the English language publications predominate, but it is assumed that such should be the case for American libraries.

TABLE II

References Counted in the *Transactions* of the American Institute of Electrical Engineers, January, 1925, to September, 1929

	Number of references	Per cent.
A. I. E. E. *Trans.*	845	28.22
Annalen der Physik	44	1.47
Archiv für Electrotechnik	69	2.30
Bell System Technical Journal	48	1.60
Electrician	49	1.63
Electric Journal	131	4.37
Electrical Review	36	1.20
Electrical World	228	7.61
Elektrotechnische Zeitschrift	59	1.97
Elektrotechnik und Maschinenbau	35	1.16
Engineering (London)	39	1.30
Franklin Institute, *Journal*	42	1.40
General Electric Review	152	5.07
Institution of Electrical Engineers, *Journal*	65	2.27
Philosophical Magazine	44	1.47
Physical Review	82	2.73
Power	57	1.90
Power Plant Engineering	32	1.06
Railway Electrical Engineer	82	2.73
Royal Society of London, *Proceedings*	35	1.16
Miscellaneous	820	27.38
Total	2,994	100.00

Some diversity of subject-matter is obtained by the selection of these particular publications, including the American, English, German and French journals.

The question of including the references to other articles in the same publication (for example, references to articles in the *Transactions* of the American Institute of Electrical Engineers, when counting references therein) has been discussed by Professor Allen in his study in the field of mathematics. It seemed desirable in the present paper to include such references with the others. The journals selected to furnish the references were the more important ones in the field. There seemed, therefore, to be no good reason for omitting references to themselves although their number might be somewhat excessive.

Also it seemed logical to reduce the references to a percentage basis so that equal weight might be given to each of the seven journals used. Table II shows the proportions of the various references listed from the *Transactions* of the American Institute of Electrical Engineers. Similar tables were made for the other six journals but have not been included in this paper.

The individual percentages from the seven tables were divided by seven and combined in Table III, giving the figures as percentages of the total. Table III shows the reference periodicals arranged in the order of their importance as determined by the method here described.

TABLE III

Reference Periodicals Arranged in the Order of their Importance

	Per cents. of total references
1. American Institute of Electrical Engineers, *Transactions*	10.851
2. *Elektrotechnische Zeitschrift*	7.925
3. *Revue Général Electricité*	7.591
4. *Electric Journal*	6.616
5. *Archiv für Elektrotechnik*	5.843
6. Institution of Electrical Engineers, *Journal*	3.888
7. *Physical Review*	3.729
8. *Philosophical Magazine*	3.157
9. *Annalen der Physik*	3.017
10. *Electrical World*	1.909
11. Royal Society of London, *Proceedings*	1.822
12. *Electrician* (London)	1.474
13. *Electric Railway Journal*	1.228
14. Franklin Institute, *Journal*	1.200
15. Académie des Sciences, *Comptes Rendus*	1.158
16. *General Electric Review*	1.129
17. *Elektrotechnik und Maschinenbau*	.997
18. *Zeitschrift für Physik*	.970

TABLE III—*Continued*

	Per cents. of total references
19. *Zeitschrift für physikalische Chemie, Stochiometrie und Verwandtschaftslehre*	.940
20. Institute of Radio Engineers, *Proceedings*	.867
21. Société Française des Electriciens, *Bulletin*	.724
22. Physical Society of London, *Proceedings*	.719
23. American Chemical Society, *Journal*	.708
24. *Bell System Technical Journal*	.664
25. National Electric Light Association, *Proceedings*	.607
26. *Electrical Review*	.593
27. *Physikalische Zeitschrift*	.521
28. *Power Plant Engineering*	.420
29. *Elektrizitätswirtschaft Mitteilungen*	.405
30. *Railway Electrical Engineer*	.389
31. *Elektrizitäts Verwertung*	.318
32. *Zeitschrift für technische Physik*	.290
33. *Power*	.275
34. *Engineer*	.231
35. *Electric Light and Power*	.231
36. American Electrochemical Society, *Transactions*	.231
37. *Siemens wirtschaftliche Mitteilungen*	.217
38. *Zeitschrift für Instrumentenkunde*	.202
39. *World Power*	.202
40. *Journal de Physique et le Radium*	.188
41. Optical Society of America, *Journal*	.188
42. *Engineering* (London)	.188
43. Société Française de Physique, *Bulletin*	.173
44. *Zeitschrift für Elektrochemie und Angewandte physikalische Chemie*	.159
45. *Physico-Mathematical Society of Japan*	.159
46. *Journal de Physique, Chimie et Histoire Naturelle Elémentaires*	.159
47. *American Journal of Roentgenology*	.159
48. Union des Syndicates de l'Electricité, bi-mensuel *Bulletin*	.145
49. Verein Deutscher Ingenieure, *Zeitschrift*	.145
50. Association Suisse des Electriciens, *Bulletin*	.145
A. Miscellaneous	23.934
Total	100.000

It will be noticed that about 24 per cent. of the references are included under the heading Miscellaneous. This is due to the method of including in the list of references, for each of the seven journals, only those appearing to a total of more than 1 per cent. of the number of references in that journal. The balance were grouped under the head Miscellaneous. Since these seven groups were added, the Miscellaneous per cent. is higher than it should be.

The publications included in Table III are those containing more than 1 per cent. of the references found in any one of the seven journals. In some cases a particular publication would total more than 1 per cent. on two or three lists and fractions of a per cent. on the other four or five. The fractions were included under the heading Miscellaneous. Had these been distributed, the effect on the total per cent. for each publication would have been slight. The combined effect on the Miscellaneous total of a number of such cases would have been greater.

For example, references to *Annalen der Physik* are more than 1 per cent. of the references listed from each of the following journals, the *Transactions* of the American Institute of Electrical Engineers, the *Archiv für Elektrotechnik* and the *Journal* of the Franklin Institute. References to *Annalen der Physik* are 0.75 per cent. of the total in *Revue Générale de l'Electricité*, 0.263 per cent. of the total in *Journal* of the Institution of Electrical Engineers, 0.50 per cent. of the total in the *Elektrotechnische Zeitschrift* and are not found in the *Electric Journal*. Since these are each less than 1 per cent., they are included under Miscellaneous, yet if they had been added to those found for the first-mentioned journals, the total Miscellaneous per cent. would have been reduced 0.22 per cent. The effect on the total for *Annalen der Physik* is negligible. Although the change in the Miscellaneous per cent. would be large if such a correction were made for all similar cases, the additional work could not be justified, since the relative order of the references would be little changed.

Since this list was made up from the standpoint of electrical engineering only, it follows that a library serving other branches of engineering, physics and chemistry should make up a composite list from similar lists for each.

It should be understood that lists such as those discussed in this paper are based upon the assumptions made, and that other investigators would probably obtain somewhat different results if permitted to make the assumptions which seemed most logical to them.

However, this problem is similar to many others in engineering. The best that can be done is to start out with the best assumptions possible and derive results which are more accurate than could be obtained by assuming the final result.

The assumptions in this case are: (1) the value of a periodical to professional workers is in direct proportion to the number of times it is cited as a reference in technical articles in the field in question;

(2) that the seven journals for the period from January, 1925, to June, 1929, give a correct view of the relative use of technical periodicals in general by American electrical engineering students, faculty and research workers; (3) that the seven periodicals used should be weighted equally.

The results obtained in this survey have cost no little effort upon the part of those interested in graduate work at this institution. Other institutions doubtless will appreciate such a list of periodicals in checking over their holdings. It is with this in mind that this paper is presented for publication.

SCIENTIFIC EVENTS

THE RAYLEIGH COLLECTION AT THE SOUTH KENSINGTON MUSEUM[1]

AMONG recent additions to the Science Museum, South Kensington, is a most interesting collection of apparatus used by the late Lord Rayleigh in the course of his scientific research. On the occasion of the unfortunate fire, last year, at Lord Rayleigh's home at Terling, Essex, a considerable quantity of apparatus was destroyed, but the historical apparatus was fortunately undamaged and the bulk of it has been generously given by the present Lord Rayleigh to the Science Museum, where it should prove a continual source of interest and inspiration to professional and amateur scientific workers alike. It is scarcely necessary to remind readers of *Nature* of the extent and importance of the late Lord Rayleigh's contributions to science. During a period of more than fifty years he published no fewer than 446 papers, every one of which made a distinct addition to our knowledge of the subject and was characterized by that lucidity and elegance of expression for which its author was renowned.

On viewing this collection, one is struck very forcibly—as were visitors to the laboratory at Terling—by the extraordinary simplicity of the bulk of the apparatus. The ability to attain results of the highest accuracy and importance by the aid of odd bits of wood, glass tubing, wire and sealing-wax was undoubtedly bound up with Rayleigh's unerring instinct in discriminating between the essential and the non-essential. It is doubtless true that some branches of modern physical research can not profitably be pursued without the use of expensive apparatus. At the same time, many workers who are apt to grow despondent after a perusal of the price-lists of the scientific instrument makers should find a tonic in the Rayleigh collection, which also serves as a salutary reminder that the man is more important than his tools.

The present collection is thoroughly representative of the vast field which Lord Rayleigh covered, and is exhibited in six cases, two dealing with acoustics, while the remainder come under the headings of optics, magnetism and electricity, argon, and miscellaneous. It is impossible in a short notice to deal adequately with the whole of the exhibits, but a few representative examples may perhaps be mentioned. The acoustics section includes apparatus used in experiments on reflection and interference and on the intensity of aerial vibrations; also the apparatus by means of which it was demonstrated that our lateral perception of the direction of a sound depends upon the phase-difference at the two ears. One of the most important exhibits in the optical section is the apparatus used for the determination of the constant of the magnetic rotation of light in carbon disulphide, while there is also a reminder that, so early as the year 1902, Rayleigh made an attempt to detect motion through the ether. Prominent in the electrical section will be found apparatus for determining the laws of resistance of periodic currents. The argon collection gives an excellent idea of the course taken in that classical series of investigations extending from 1892 to 1895 in the latter part of which Sir William Ramsay collaborated, while under "Miscellaneous" the chief exhibits deal with capillarity, fluid motion, and cognate problems. Every piece of apparatus has been provided with a full explanatory label giving references to the original source and to the "Collected Scientific Papers," and public lectures on the exhibits will be given from time to time.

[1] From *Nature*.

THE NEW SCIENTIFIC LABORATORIES AT THE UNIVERSITY OF CHICAGO

Two new science buildings, each believed to be the finest of its kind in the United States, were opened recently at the University of Chicago for the first time to accommodate summer quarter classes. The recently completed buildings are the Bernard A. Eckhart Hall of Mathematics, Mathematical Astronomy and Physics and the new Botanical Research Laboratory.

Seventeen classes in mathematics and astronomy moved into the Eckhart building, the erection of which was made possible by a gift of $710,000 from Mr. Bernard A. Eckhart. Adjoining the older Ryerson Physical Laboratory on the east, the new structure rises to four floors along University Avenue on the Main Quadrangle.

Eckhart Hall, the work of Charles Z. Klauder, Philadelphia architect, is said to be one of the finest

of the university's Gothic buildings. Basement and first floor are devoted to thirty-eight research rooms for the department of physics, part of which will be used for the work of Professors Arthur H. Compton and Arthur J. Dempster and their graduate students. Professor Michelson will retain his laboratory in Ryerson, where he has worked for many years.

The upper floors will be used by mathematicians and astronomers, departments which for the first time will have adequate facilities. In addition to nine classrooms there are thirty-nine offices for the faculty, fellows and graduate students of those departments. Other features of Eckhart Hall are an assembly room seating 240 and a library with facilities for 88 readers and 50,000 volumes.

Three laboratory classes in plant physiology now occupy the new Botanical Laboratory.

There are no classrooms or library in the laboratory, which adjoins the group of greenhouses finished last year. It is to be devoted to research in plant physiology and plant pathology.

Features of the new buildings are its biochemical and biophysical laboratories, where studies such as those on the effect of X-rays on plants will be prosecuted. Constant temperature rooms, where cold as low as 40 degrees below zero can be maintained; inoculation quarters, in which the entire room may be given a shower or steam bath, so that plant disease germs may be transferred without contamination; animal quarters for the study of the plant germs they carry; rooms which reproduce the conditions under which fruits and vegetables are moved; X-ray and seed-germination rooms are also features of the laboratory.

SUMMER MEETING OF THE BOTANICAL SOCIETY OF AMERICA

THE Summer Meeting of the Botanical Society of America will be held in August at the Puget Sound Biological Station at Friday Harbor, Washington.

The local committee, of which Professor T. C. Frye is chairman, has arranged a tentative program in which indoor discussions and a variety of trips and excursions to points of varied interest find place. Unusually favorable tide conditions will offer an excellent opportunity to study the wonderful algal flora of these waters. Many will appreciate the chance to see a sample of the great forest growth of the northwest.

PROGRAM

August 19—Tuesday

Afternoon—Registration at the station office.

8 P. M. Address of welcome.
Lecture on "The Geology of the San Juan Islands."

August 20—Wednesday

8:30 A. M. Marine dredging for algae at Canoe Island.
8:30 A. M. Auto trip to Castle Point for wind effects, forest and prairie gradation.
8:30 A. M. Trip to Douglas Fir Forest.
1:00 P. M. Dr. E. J. Lund will demonstrate electrical polarity in the Douglas Fir.

August 21—Thursday

8:30 A. M. Visit in row boats to Nereocystis beds.
8:30 A. M. Marine dredging and marine ecology.
8:30 A. M. Trip to fields.
2:00 P. M. Discussion—Meetings of groups interested in algae, ecology and mycology.

August 22—Friday

All sections will participate in an early morning drive to False Bay, where tide recedes half a mile. Return to station for lunch.

Tents, meal accommodations, boats and other facilities of the station will be at the disposal of members of the society and guests. At this meeting the spirit of informality will prevail, as at the earlier summer meetings, and all will find much to enjoy in the friendly give-and-take of the occasion. Parking space for automobiles and tenting grounds for those traveling in this way will be available.

RODNEY H. TRUE,
Vice-president for the Committee on Arrangements

FIRST AWARDS OF THE PACK FOREST EDUCATION BOARD

MAKING its first award of fellowships ranging up to $1,800 a year for training leaders in forestry, the Charles Lathrop Pack Forest Education Board has announced its selection of five Americans and one Canadian for the year 1930. The winning candidates were chosen from about ninety contestants. The fellowships were established to encourage men of unusual intellectual and personal qualities to obtain training that will equip them for important work, either in the general practice of forestry, in the forest industries, in the teaching of forestry, in forest research, or in the development of public forest policy. The successful candidates are:

James Lindsay Alexander, assistant professor, College of Forestry, University of Washington. To make an investigation of forest survey methods with the object of developing the needed precision with the least cost at the University of Toronto, the University of Washington and in the forests of the eastern and western United States.

Ralph Caird, graduate student, University of Chicago. To make a general study of forestry at the School of Forestry and Conservation of the University of Michigan, and to do advanced work in tree physiology and pathology.

Bernard Frank, assistant forest economist, U. S. Forest Service, Washington, D. C. To make studies at the University of Wisconsin and field investigations in the Lake States of land classification methods and land utilization technique especially as applied to forest lands, together with the preparation of a program of land use for a specific region.

George Ritchie Lane, forester in charge of reforestation, Canada Power and Paper Corporation, Grand' Mere, Province of Quebec, Canada. To make field investigations of the planting, growth and yield of pulpwood species in the Maritime Provinces of Canada, in the hope of reducing the costs of reforestation.

Raymond Frank Taylor, forest examiner, U. S. Forest Service, Juneau, Alaska. To make studies of the silvicultural management of coniferous forests at the School of Forestry, Yale University, supplemented by field work in Washington and Alaska.

John Burton Woods, forester, Long-Bell Lumber Company, Longview, Washington. To make field investigations and to gather material on forestry as practiced in private timberlands and to write a book on the application of forestry to private lands.

During the coming autumn the Forest Education Board will receive applications for the award of approximately eight additional fellowships for 1931–32.

APPOINTMENTS IN THE U. S. GEOLOGICAL SURVEY

R. C. WELLS has been appointed chief chemist in charge of the Division of Chemistry in the U. S. Geological Survey, and George Steiger, former chief, will return to studies in chemical and spectroscopic analysis.

W. D. Johnston and F. G. Wells have been transferred from the Water Resources Branch to the Geologic Branch and assigned to field work.

Eugene Callaghan, Edwin B. Eckel, Charles L. Gazin, E. N. Goddard, Charles B. Hunt, Bernard N. Moore, Watson H. Monroe, Charles F. Park, Jr., and Aaron G. Waters have been appointed junior geologists, and Lloyd G. Henbest, J. Harlan Johnson, Maxwell M. Knechtel, Albert H. Koschmann, Robt. E. Landon, Charles B. Read, Philip J. Shenon, Ralph B. Stewart and J. Steele Williams, assistant geologists in the Geologic Branch, U. S. Geological Survey.

Richard C. Cady and Stanley W. Lohman have been appointed junior geologists in the Water Resources Branch.

Stanly Cathcart, formerly connected with the Geological Survey, was reinstated as geologist in the Conservation Branch, but has recently joined the Pennsylvania Geological Survey staff.

Ralph W. Richards has been reinstated as geologist in the Geologic Branch.

Wendell P. Woodring, for the past few years on the staff of the California Institute of Technology, resumed full time service with the U. S. Geological Survey on July 1, 1930.

SCIENTIFIC NOTES AND NEWS

THE first meeting of the National Academy of Sciences to be held west of Wisconsin will take place from September 18 to 23, opening at the University of California, moving to Stanford University on the third day, and to the California Institute of Technology in Pasadena for the following two days. Arrangements for the meeting are in the hands of a committee including Director Robert G. Aitken, of the Lick Observatory, Professor A. O. Leuschner and Professor William C. Bray, chairman, all of the University of California; Professor W. F. Durand, of Stanford University; Robert O. Schad, of the Huntington Library; Dr. F. H. Seares, of the Mount Wilson Observatory, and Professor Richard C. Tolman, of the California Institute of Technology. Addresses of welcome at the three institutions respectively will be made by President Robert Gordon Sproul, of the University of California; Acting President Robert E. Swain, of Stanford University, and Dr. Robert A. Millikan, chairman of the executive council of the California Institute of Technology. Dr. Isaiah Bowman, of the American Geographical Society, will give an address on the opening day of the session, at 8 p. m. in Wheeler Auditorium, University of California.

BARON GERARD JAKOB DE GEER, Stockholm, and Professor Tullio Levi-Civita, Rome, have been elected foreign members of the Royal Society, London.

WE learn from *Nature* that at a meeting of the Royal Society of Edinburgh, held on July 7, the following were elected honorary fellows: *British Honorary Fellows*—Sir Arthur Stanley Eddington; Sir William Bate Hardy; Sir Arthur Keith; Professor J. E. Marr; Professor R. Robinson, Dr. D. H. Scott; *Foreign Honorary Fellows*—Professor V. F. K. Bjerknes, Bergen; Professor W. B. Cannon, Cambridge; Professor M. Caullery, Paris; Professor G. Fano, Rome; Professor E. H. O. Stensiö, Stockholm.

PROFESSOR CHARLES MORSE ALLEN, emeritus head of the department of chemistry at Pratt Institute and son of Dr. Charles Frederic Allen, the first president of the University of Maine, received the degree of doctor of laws at the fifty-ninth commencement of the university.

AN honorary degree of doctor of science has been

conferred by Wabash College upon Professor Samuel J. Record, research associate in wood technology on the botanical staff at Field Museum of Natural History.

ON Wednesday evening, July 9, about forty colleagues and friends of Professor Edwin D. Starbuck, head of the department of philosophy and director of the Institute of Character Research at the University of Iowa, tendered him a fellowship dinner in the Memorial Union. A number of addresses were given in appreciation of his twenty-four years of service at the University of Iowa on the eve of his departure for the University of Southern California, where he has accepted a position as professor of philosophy. A leather bound volume of personal letters addressed to him by his colleagues was presented.

DR. CLARA STOLTENBERG, professor of anatomy at Stanford University, was the guest of honor recently at a dinner given in Stanford Union by a group of her friends. The affair was in the nature of a farewell to Dr. Stoltenberg, who will retire at the close of the present quarter, after having been a member of the faculty since 1896. Tributes were paid to her by Dr. Thomas M. Williams, '97, and by Professors Isabel McCracken, '04, Frank M. MacFarland, '93, and Oliver P. Jenkins. Approximately ninety friends and colleagues were present.

DR. A. R. JOHNSTON, research associate in the department of physiology of the University of Cincinnati, has been granted $1,000 by the committee on scientific research of the American Medical Association to further his studies of the toxic action of the amines as found in nature or produced by disease.

DR. JESSE H. WHITE, head of the department of psychology at the University of Pittsburgh, has been elected president of James Millikin University at Decatur, Illinois.

AT the University of Minnesota, Dr. D. E. Minnich has been appointed chairman of the department of zoology, succeeding Dr. W. A. Riley, who has resigned to become chief of the division of entomology and economic zoology, following Dr. R. N. Chapman. Dr. Riley will continue his professorship in the department of zoology.

DR. MARY ISABEL MCCRACKEN has been promoted to a full professorship of zoology at Stanford University.

DR. H. W. GILLETT, director of the Battelle Memorial Institute, Columbus, Ohio, announces the appointment of Mr. Byron M. Bird, of the U. S. Bureau of Mines, as chief concentration engineer. Mr. Bird joined the staff of the institute on July 1 and assumes responsibility for research work on both ore dressing and coal preparation under the direction of Mr. Clyde E. Williams, assistant director.

SIR FREDERIC GEORGE KENYON, since 1909 director and principal librarian of the British Museum, will retire at the end of this year.

PROFESSOR E. J. GARWOOD, representing the London Geological Society, addressed the Geological Society of France during its centenary celebrations in the Sorbonne on June 30.

AT the University of North Carolina, Dr. C. Dale Beers, associate professor of zoology, has been granted a year's leave of absence, and Dr. J. M. Valentine, acting-assistant professor of zoology during the current absence in Italy of Professor H. V. Wilson, has been reappointed for the coming year. Dr. Beers will spend the greater part of his year's leave as guest investigator in the Kaiser Wilhelm Institute for Biology, at Berlin-Dahlem, where he will be associated with Professor Max Hartmann.

THE Rockefeller Institute for Medical Research will be represented abroad this summer at several international scientific conferences. Dr. Alexis Carrel is to report on new techniques in cytology at the Second International Congress of Cytology in Amsterdam. Dr. Karl Landsteiner and Dr. Thomas M. Rivers are to report at the International Microbiological Congress in Paris on blood groups and filterable viruses, respectively. Dr. Peter K. Olitsky is to report on *Bacterium granulosis* (Noguchi) at the meeting of the International Union against Trachoma to be held under the auspices of the Health Section of the League of Nations in Geneva. Dr. Wade H. Brown is to report on experimental syphilis at the Eighth International Congress of Dermatology and Syphilology in Copenhagen. Dr. Ralph W. G. Wyckoff will attend the meeting of the International Committee to Standardize Nomenclature and to Prepare Tables in Crystal Analysis, to be held in Zürich.

DR. LEO LOEB, of Washington University, St. Louis, is spending the summer in study and research at the Scripps Institution of Oceanography at La Jolla.

MR. M. W. STIRLING, chief of the Bureau of Ethnology, is making an archeological reconnaissance in Nevada and Texas.

DR. WALDO L. SCHMITT, curator of the Division of Marine Invertebrates, U. S. National Museum, left on July 5 to spend six weeks at the Carnegie Marine Laboratory at Tortugas, Florida. He will continue a study of crustacean contents of fish stomachs which he is making in collaboration with Dr. William H. Longley, of Goucher College, director of the Carnegie Laboratory.

THE second radio talk in the series presented by the

American Association for the Advancement of Science in cooperation with the National Broadcasting Company will be given on Monday, July 28, at 7:00 P. M., eastern standard time. The subject will be "Notes from the last Cruise of the *Carnegie*," and the speaker will be Mr. O. W. Torreson, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, who was navigator and executive officer of the *Carnegie*. Mr. Torreson will describe for the first time some of the new contributions to knowledge resulting from the work of the *Carnegie* and explain their importance to the world at large. The third talk in the series will be on the investigations being undertaken this summer in the Hawaiian Islands by the U. S. Bureau of Fisheries. It will include the first announcement of the results of these investigations. This talk will be given, at a date to be announced later, toward the end of September, and the speaker will be Dr. Paul S. Galtsoff, of the Bureau of Fisheries.

FOUR members of the faculty of the University of Minnesota were honored by the selection of their symposium, "The Measurement of Man" (University of Minnesota Press), a study in biometrics, as the August "book of the month" by the Scientific Book Club. The authors were the late Dr. J. Arthur Harris, who was head of the department of botany; Dr. Clarence M. Jackson, director of the Institute of Anatomy; Dr. Richard E. Scammon, professor of anatomy, and Dr. Donald G. Paterson, professor of psychology—all of the University of Minnesota. The papers presented in this symposium were originally lectures delivered at the university under the auspices of Sigma Xi. Dr. Harris contributed "The Measurement of Man in the Mass"; Dr. Jackson, "Normal and Abnormal Human Types"; Dr. Scammon, "The Measurement of the Body in Childhood," and Dr. Paterson, "Personality and Physique." The book will be published on August 12.

LEAVE of absence, according to *The Experiment Station Record*, has been granted by the University of California to Dr. W. P. Kelley, professor of agricultural chemistry and agricultural chemist, to undertake a survey sponsored by the American Society of Agronomy in cooperation with the university as to the present status of nitrogen fertilizer research in the United States and Europe; Dr. W. L. Howard, director of the Davis branch of the College of Agriculture, for six months to be spent in study and travel in Europe, during which time T. F. Tavernetti, assistant to the dean of the College of Agriculture, will serve as acting director at Davis; F. T. Bioletti, head of the division of viticulture and fruit products, in connection with further exploration studies in the Mediterranean region, mainly as related to the horticultural needs of the southwestern United States and in cooperation with the U. S. D. A. Bureau of Plant Industry; E. B. Babcock, head of the division of genetics, for four months for travel in foreign countries for the purpose of collecting specimens, and Asher Hobson, professor of agricultural economics in the Giannini Foundation of Agricultural Economics, to enable him to organize and develop a foreign agricultural information service for the U. S. D. A. Bureau of Agricultural Economics and the Federal Farm Board.

DELEGATES to represent the United States at the fourth World's Poultry Congress, to be held in London this month, sailed from New York on July 9. These include W. F. Priebe, Chicago; Mrs. Lucy B. Garber, Enid, Okla.; C. I. Bashore, Silver Lake, Ind.; Gordon M. Curtis, Dayton, Ohio; Dr. Leslie E. Card, Urbana, Ill.; Harry R. Lewis, Greenwich, R. I.; Harold A. Nourse, St. Paul, Minn.; D. Lincoln Orr, Cornwall, N. Y.; Arthur M. Peine, Manhattan, Kans.; F. H. Cockell, Milwaukee, Ore.; W. A. Scheit, Syracuse, N. Y.; L. B. Kilbourne, Chicago; Dr. John R. Mohler, Department of Agriculture; Dr. Morley A. Jull, Department of Agriculture; R. R. Slocum, Department of Agriculture, and S. D. Sanders, Seattle, Wash. The resolution authorizing the appointment of these delegates also provides for an authorization of $15,000 for their expenses. The government had previously provided the sum of $25,000 to cover the cost of a national exhibit.

A NOTE concerning the dedication ceremonies of the new medical building of the University of Brussels printed in the issue of SCIENCE for July 4 contains several inaccuracies. It should have read: The buildings were erected jointly by funds provided by the Rockefeller Foundation and the city of Brussels. The degree of *doctor honoris causa* was conferred on Dr. Simon Flexner, director of the Rockefeller Institute, and on Dr. Abraham Flexner, formerly of the General Education Board, who was recently elected director of the newly established Institute for Advanced Study at Newark, New Jersey.

A CONTRACT, representing an expenditure of more than $291,000 for 5,735 milligrams of radium and accessory equipment to be delivered to the State Institute for the Study of Malignant Diseases at Buffalo, was recently signed by Dr. Thomas Parran, Jr., state commissioner of health. Certificates of the U. S. Bureau of Standards attesting the quantity of radium element will be delivered with the material. The purchase was made possible by an appropriation of $300,000 for the purpose at the last session of the state legislature. With the acquisition of this additional radium, the institute, so far as known, will possess the largest single supply in the world.

THE will of the late Elmer A. Sperry, the distinguished engineer, who died in Brooklyn last month, creates a trust fund of $1,000,000, the income from which is to go to the Young Men's Christian Association. Half the income will go toward the seventy-fifth anniversary drive of the Brooklyn and Queens Y. M. C. A. for ten years, and the other half will be applied on the building fund of the Flatbush Y. M. C. A. After ten years the income will be used in any way that the national board of the organization may designate, although Mr. Sperry included in his will a wish that special preference always be given to the Flatbush branch.

THE British Minister of Health, Mr. Arthur Greenwood, after consultation with the London County Council and the senate of the University of London, has appointed a Provisional Organization Committee to proceed with the action necessary to secure the establishment of the British Postgraduate Hospital and Medical School. The terms of reference of the committee are to consider and report, in pursuance of the statement made by the Minister of Health in the House of Commons on April 9, upon (1) the action requisite to lead up to the planning and construction of the Medical School and (2) the form of government appropriate to the Hospital and Medical School, with special reference to the position of the London County Council as the local authority responsible for the hospital, and to the position of the University of London in relation to the school. The chairman of the committee is the Rt. Hon. Viscount Chelmsford. The Ministry of Health will be represented by Sir George Newman, chief medical officer, and Mr. M. Heseltine, assistant secretary. The London County Council will be represented by Miss F. Barrie Lambert, Sir William Ray, Mr. Angus N. Scott and Mr. L. Silkin. The University of London will be represented by the Rev. J. Scott Lidgett, the vice-chancellor elect; Mr. Sidney L. Loney, the chairman of convocation and deputy chairman of the court; Mr. H. L. Eason, superintendent and senior ophthalmic surgeon, Guy's Hospital, and Dr. Edwin Deller, principal.

DISCUSSION

THE MAGNETIC POLES OF THE EARTH AND THE BIRTH OF THE MOON

GEOPHYSICISTS recognize many structural asymmetries of the earth, such as the existence of continents of land and an elliptical figure of an equatorial sea-level section. The inequality of the two axes of this ellipse is of the order of one kilometer, the major axis terminating in central Africa and in Hawaii, the minor axis in Sumatra and the Andes.[1]

A remarkable asymmetry exists in the longitude of the earth's magnetic poles, which are at present in 96° west and 155° east longitudes. They are, therefore, only 109° apart, and their longitudes mark out roughly the average boundaries of the Pacific Ocean, the vast basin of which has many "deeps" and is enclosed by a giant circlet of extinct and active volcanoes. If this basin is the birthplace of the moon, it does not seem unreasonable to expect that enough of the heavier, deep-lying magnetic elements in the earth may have been torn along, placenta-wise, on that natal occasion to actually fix the magnetic poles of the earth in these regions. Perhaps it would be better to say that when the lunar material departed, a shift in the distribution of magnetic materials within the remaining mass took place toward the Pacific basin.

While it seems difficult to believe that the readjustment of the earth to approximately spherical form after such an enormous loss could leave anything fixed, other asymmetric vestiges of diastrophic changes in the earth during its long history have survived so that the one discussed here may not be ruled out *a priori*.

Attention may have been called to this bit of circumstantial evidence that the moon was born of the earth, but I have not found any mention of it in a casual perusal of several recent books on geology and geophysics.

OLIVER JUSTIN LEE
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[1] See Jeffreys, "The Earth," p. 222.

EFFECT OF WATER ON TRIBOELECTRIC LUMINESCENCE WITH MERCURY IN GLASS

THOSE who have investigated the phenomenon of the faint flashing to be observed when mercury moves over a glass surface in a vessel containing gas at low pressure seem to have concluded quite unanimously that the presence of water destroys the effect.

The authors have determined that this statement is subject to a certain limitation. For Pyrex glass, at any event, and presumably for other glasses, the presence of water vapor makes no difference unless saturation is approached.

The observations resulted from watching the operation of a Töpler pump in a darkened room. In the absence of water vapor, the fall of mercury in the pump was accompanied by periodic flashing during the entire time of the down-stroke. When, however, water vapor at about half saturation pressure was admitted, the up-stroke of the pump resulted in

condensation of water on the glass walls after the mercury had more than half filled the pump, and practically no water was carried over by the mercury at the end of the stroke; then, during the fall of the mercury, no flashing was to be observed at first, but it commenced abruptly and continued after the mercury had come about halfway down. With varying original partial pressures of water vapor, the point at which flashing began differed; but in each instance there was complete absence of flashing while the space above the mercury was saturated, and flashing occurred as in a perfectly dry pump as soon as the space was less than saturated.

These results seem reasonable enough. No considerable potential difference between the mercury and the uncovered glass above it can build up, by separation of the glass and mercury, as long as a slightly conducting film of liquid water is on the glass; but as soon as the liquid film has evaporated, separation of the glass and mercury, as the latter falls in the pump, gives increasing potential difference until discharge through the space above the mercury, with an accompanying flash, occurs; and unsaturated water vapor does not interfere with the process.

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GAS DISCHARGE WAVE-LENGTH LIST IN THE EXTREME ULTRA-VIOLET

We have prepared a list, arranged in order of wave-length, of the published lines in the extreme ultra-violet (λ 2500 to λ 100) arising from discharges in gases. The elements included are hydrogen, helium, carbon, nitrogen, oxygen, neon, sodium, silicon, argon and mercury. Thanks to support from the Carnegie Institution of Washington it has been possible to publish a limited mimeographed edition of the list, copies of which have been sent to a few spectroscopists to whom we thought it might be of particular use. We should be glad to give copies to any others who may write requesting them.

Janet M. MacInnes
Joseph C. Boyce

Palmer Physical Laboratory,
Princeton University

MORE ABOUT A UNIFORM BIBLIOGRAPHIC SYSTEM

In the issue of Science for January 10, 1930, Dr. M. C. Merrill, editor of the *Journal of Agricultural Research*, calls attention to certain alleged disadvantages of the name-date system of presenting literature citations. He involves the name-date system in an instance of *reductio ad absurdum* by citing a case where nineteen literature citations were noted at one point. The case used to illustrate the alleged absurdity is rather an exceptional one. An inspection of current articles in a variety of scientific journals will show that the total number of literature citations in the text of papers which refer to a large number of papers is comparatively small. A survey of over 5,100 citations has shown that over 95 per cent. referred to only one article in the bibliography; over 3 per cent. referred to two articles; more than 1 per cent. to three articles, while .31 per cent of them referred to four articles. This makes the proverbial 99.4 per cent. of these citations which referred to one, two or three articles, or 99.9 per cent. of the citations referring to five articles or less. One citation was found in the *Journal of Agricultural Research* which referred to seventeen different articles. This calculates to .01946 per cent. Dr. Merrill calls attention to one other such exception. No others were found containing more than seven citations at one point. It might also be mentioned that, of the ten lines used by Dr. Merrill in his elaborated citation in Science, nearly three are given over to comments not usually incorporated in such citations.

The use of the letters *a, b, c*, etc., to differentiate between papers published the same year by one author is no more cumbersome than their use for insertion of additional references into a completed manuscript at the galley-proof or other stage. The writer prefers an alphabetical list of references in practically all instances.

Attention is called to the situation where two years' numbers of a journal are bound into one volume. In this connection we should recall that where the name-number system is used the date is included under "literature cited," and it is as easily made accurate and definite by the name-date as by the name-number system. Furthermore, the name-date system keeps before the reader the information regarding the date of publication, which is an aid in evaluating in many instances.

Undoubtedly no one bibliographic system is perfect, nor will it cover all the exceptional cases. Certain possible improvements were suggested in the August 30 issue of Science. An additional suggestion is the desirability of using bold-faced type to designate the volume number. The advantages of giving the full titles under "literature cited" and of giving a definite and uniform position to each of the four items —name, date, title and literature reference—are again emphasized. This latter suggestion varies from the form used by various journals mainly in placing the reference itself upon a new line in each case rather

than letting it follow the title as is now frequently customary.

Although the writer prefers the name-date system, he is more interested in the matter of uniformity among the different journals. Dr. Merrill apparently agrees with the idea of the desirability of uniformity. If a uniform and improved bibliographic system, the printing expense of which will not be more than the value received, may be cooperatively evolved and adopted, the purpose of the writer's original article will have been accomplished. Such a result can not, however, be accomplished without cooperation in relinquishing certain cherished bibliographic forms by practically all those interested.

Since the foregoing part of this note was written, an editorial has appeared in the January 20 issue of the new edition of *Industrial and Engineering Chemistry* emphasizing the need of standardization of literature references. The present writer believes that a standard form of bibliography and citation should be based upon the preference of those who search the literature with due regard to the preference and convenience of the publisher and printer. The opinions expressed by Dr. Merrill and by *Industrial and Engineering Chemistry* are more from an editorial viewpoint. Those most interested and most affected are the research man, the author and the teacher who use the literature as a basis for scientific progress. An expression of opinion from a large number of men who are interested primarily from the investigators' standpoint should be obtained. Following the adoption of a standard system authors should be required to conform before their papers are considered for acceptance. Let us hope that further consideration may result in the adoption of a uniform standard system for all scientific journals.

J. L. ST. JOHN

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ATTACK BY A SCREECH-OWL

IN the SCIENCE issue of November 1, 1929, there was a short article by Mr. Albert M. Reese, of West Virginia University, about an attack of a screech-owl on several residents of Morgantown, West Virginia.

About 1915, on a farm in north central Mississippi, I had a somewhat similar experience. A colored boy about fifteen years of age complained to me that he was being attacked from the air by some mysterious birds in a wooded section along a creek. These attacks were experienced by the boy between sundown and dark. I went with him the next evening after the complaint was made to the place where the attacks had occurred. Down swooped the birds over our heads, making sounds like some one slapping two thin boards together. They tipped the top of my head several times but did no harm. We scared them off with sticks after they had made many attempts to scratch our heads. I went back to the same place on several evenings for new experiences, even though it did make the cold chills run up my spine to be attacked from the air by birds that I could not see until they were right on me. I took my gun along one evening, and again without warning the attack was on. I saw an object move on a branch of a tree about ten feet from the ground and I fired. Down came a young screech-owl. From then on there were no more attacks by the parents of this young owl. My idea is that screech-owls will attack people only when they have a nest or young birds around. Screech-owls are like many other birds, in that they protect their young ones even after they begin to fly.

W. W. CHAPMAN

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MARMOSA AS A STOWAWAY AGAIN

IT seems worth while to add still another note concerning the finding of this small Marsupial, Marmosa (known as the mouse opossum), on a banana stalk in a grocery store. This time it is quite a family group, the female and a litter of nine young. They were found here in a store in Waco, Texas. It was impossible to learn whether the bananas had come from Porto Rico or Central America since the jobber had both in the warehouse.

In this case the interesting feature is the large size of the litter. Rather large litters might be expected from opossums, but the other cases reported have been much smaller. Dr. L. A. Adams, of the University of Illinois, in SCIENCE of February 24, 1928; Professor Geo. Wagner, of the University of Wisconsin, in SCIENCE of April 20, 1928, and Professor Robert K. Enders, of Missouri Valley College, in SCIENCE of April 25, 1930, have all mentioned one or two young with a female. Mr. E. R. Warren in SCIENCE of April 20, 1928, mentions a litter but not the number. It is also interesting to note that the adults reported are females. This may be due to the fact that the female attempts to hide with the young and does not escape before or during the shipment.

The color of the fur of the adult in this case is a golden brown with darker lines through the eyes. The young are almost pure brown. All nine are carried on the back and sides of the mother. They cling to the fur with their mouths and feet and occasionally are aided by the prehensile tail. The mother has been seen to toss the young from the floor to her back with her nose, and the young grasp the fur of her back upon alighting.

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QUOTATIONS

THE PEKING SKULL

THE arrival of the official report on the Peking skull and the opportunity we now have of studying the undeveloped cast of it, which recently arrived in England, enable me to answer the many queries I have received as to the reasons for attaching to the discoveries in China the exceptional importance defined in my letter to *The Times* two months ago.

(1) *Sinanthropus* comes from a geographical area in which previously early man was unknown. While the remains are of approximately the same age as *Pithecanthropus* and *Eoanthropus*, the Man of Peking is generically distinct from both the Ape Man of Java and the Piltdown Man.

(2) The jaws and brain-case found at Chou Kou Tien reveal features some of which were hitherto unknown in any human skull except *Pithecanthropus*, while others were regarded as distinctive of the Piltdown skull. Hence the newly discovered specimens provide a link between these two types and reconcile what hitherto has been their puzzling lack of conformity with one another. Thus they give cohesion to our knowledge of the earliest human remains and add stability to our conception of the qualities likely to be found in the earliest common ancestor of all three, the as yet undiscovered Pliocene Man.

(3) The Peking skull was found, not in gravels where broken fragments were scattered and deposited by running water (as happened in the cases of the Java and the Piltdown skulls), but in the floor of a cave where the Man of Sin actually lived and died. Hence the association of the human remains with those of the early Pleistocene animals found alongside them is certain, and affords for the first time unquestionable evidence that the remains of Early Man do really belong to the Lower Pleistocene. Moreover, the conditions under which the bones were found suggest the probability that other parts of the same skeletons may be found during the further excavation of this site.

(4) The fact that the skull was found in an uncrushed state and in a form less incomplete than those of *Pithecanthropus* and *Eoanthropus* gives us a fuller and more convincing idea of the form of the brain-case in one of the earliest types of mankind, and corroborates the essential accuracy of the reconstruction of the Piltdown skull made by Sir Arthur Smith Woodward in 1912.

(5) The temporal region of the Peking skull presents features of quite exceptional interest and importance. It is much more primitive than that of the Piltdown skull, and reveals a striking resemblance to the condition that is normal in the adult anthropoid apes, and some analogy to that of the modern human infant. The features of this part of the skull (which unfortunately is unknown in the case of *Pithecanthropus*) afford new and emphatic testimony of the closeness of the kinship of man and the anthropoid apes.

(6) The fact that this skull was found in Eastern Asia does not settle the problem as to the original cradle of the human family. Long before the emergence of man, anthropoid apes (whose facilities for rapid migration were strictly limited by their lack of adaptability to new conditions) had wandered as far as Western Europe, South Africa and Eastern Asia. One can therefore assume that in Pliocene times primitive men, distinguished by the characteristically human qualities of greater adaptability and freedom of movement, had roamed throughout the same extensive territory as their less enterprising Simian ancestors had previously explored. Hence the three widely differentiated genera of Early Pleistocene Man found respectively in Java, England and China represent the scattered descendants of ancestors who had already been wandering east and west throughout the vast Euroasiatic continent for hundreds of thousands of years before any one of the three genera left the skulls in the places where they have recently been found. Hence the evidence they provide has little relevance to the determination of the birthplace of the Human Family.—G. ELLIOT SMITH *in the London Times.*

SCIENTIFIC BOOKS

Titanotheres of Ancient Wyoming, Dakota and Nebraska. By HENRY FAIRFIELD OSBORN. U. S. Geological Survey, Monograph 55, 1930. 2 vols., 4to, xxiv + 953 pp., 236 pls., 797 figs.

THE titanotheres are without doubt one of the most interesting of mammalian groups. Commencing in the early Eocene with hornless forms, some of which were no larger than a coyote, they increase rapidly in size and numbers, reach a climax in the huge horned types of the lower Oligocene and then, at the peak of their development, abruptly disappear. Their size and abundance and the fact that their center of evolution appears to have been our Western states have facilitated the collection of large quantities of material and rendered possible a more complete account of their evolutionary history than is the case with any

other vertebrate group except the equids. Published facts on the group, however, have been widely scattered in the literature, and no comprehensive account has ever been given.

In consequence, the appearance of Professor Osborn's monograph has been eagerly awaited. Begun by him in 1900, it was sent to press in 1919 and finally has appeared this spring.[1] The delay has been long; but it is forgotten when one sees the magnificent work which has eventually appeared. For completeness and breadth of treatment the monograph leaves nothing to be desired. As to its thorough nature, one need merely cite the magnitude of the work: nearly a thousand pages of quarto text, more than two hundred plates, nearly eight hundred text figures. Every angle of titanothere evolution has been comprehensively treated. But the monograph is more than its title implies, for the various aspects of the subject have led the author into interesting discussions of many topics of a broader nature. It can not, I think, be questioned that Professor Osborn's hopes will be fulfilled in that the monograph has set a new standard of broad, thorough and exhaustive research in vertebrate paleontology, and that it will exercise a permanent influence upon future studies of the geological history of the great West.

The work may be, for purposes of review, divided into three sections. Chapters I to IV deal with introductory matters; in Chapters V to VIII the facts concerning titanothere morphology are set forth, while in Chapters IX, X and XI the data are summarized and applied to the solution of adaptational and evolutionary problems. In addition, a short appendix brings the work up to date with an account of recent discoveries of titanotheres in Mongolia.

In Chapter I, "An Introduction to Mammalian Paleontology," Professor Osborn, using the perissodactyls as examples, outlines the problems to be met with and his method of attack. He gives an interesting discussion of systems of classifications. In the days of Linnaeus, when evolution was undreamed of and fossils were merely curiosities, taxonomy was a simple problem. A family or genus was a clear-cut group, readily definable through the presence or absence of definite characters. But to-day with an extra, paleontological, dimension thrown into the picture, definition is far more difficult, if we attempt to retain a "natural," vertical, classification. To take the case of the titanotheres themselves as an example, all the later, Oligocene types are large, heavy-limbed, horned types. If these forms were living to-day and we had no knowledge of their history, their common characteristics could be used in definition of the group. But we know, as a result of Professor Osborn's work, that the numerous Oligocene phyla have all been derived independently from small hornless Eocene forms. As our knowledge grows, definitions become increasingly difficult; there are few definite characters, for example, by which *all* titanotheres may be distinguished from the horses or rhinoceroses. It is only by tendencies towards the acquisition of certain new features and proportions that we may characterize a group.

Resulting from this situation, the main criteria upon which the author bases his interpretation of the titanothere family tree are (1) the incidence of new characters ("rectigradations") and (2) characteristics resulting from changes in proportions ("allometrons"). Rectigradations through growth become allometrons, and since new characters appear comparatively rarely in the group, emphasis naturally is placed on allometrons (as, for example, dolichocephalic and brachycephalic tendencies in the skull). The velocity with which changes of proportion take place is stressed, and apparently justifiably so, as an index to relationship.

With regard to modes of evolution, the author propounds the question as to whether there is "evidence of chance origins and chance rudiments of certain types of structure possessing sufficient survival value to establish themselves through the principle of the survival of the fittest, or whether there is some other orthogenetic principle at work causing the definite and adaptive origin of new characters."

A second chapter, treating of the geological environment of the titanotheres, covers far more ground than the title indicates, for it includes a comprehensive survey of early Tertiary stratigraphy and discussion of the division of this period of time on the basis of faunal zoning as well as an account of the physiographic, floral and faunal environment of the titanotheres. Chapter III gives a chronological account of titanothere discoveries, in which original descriptions and type figures are reprinted in full, while a short fourth chapter details earlier classifications of the group and the classification finally adopted for the monograph.

With Chapters V and VI we are plunged into the main body of the work, for these sections deal with the structure of the skull and dentition of Eocene and Oligocene titanotheres. An immense amount of material is described in the three hundred pages devoted to this topic; in many instances a dozen or more

[1] The task of putting a huge scientific work of this character through the press is time-consuming in itself. But in addition one is at liberty to suspect that the unfortunate "economies" to which the Geological Survey has been subjected during the past decade may have been a major reason for the delay. It is to the lasting credit of the survey that it has been able to publish such a work of pure science despite its straitened financial position.

skulls of a single species are figured and measurements given. Among the striking features of the titanothere skull is the extreme conservatism shown in the persistently low-crowned teeth and the small brain, in contrast with the wide range of variability in skull proportions and the almost simultaneous independent development of horns in the various phyla near the close of the group's history.

But although the skull and teeth are the center of interest, the remainder of the skeleton is by no means neglected, but is discussed in Chapter VII. However, as Professor Osborn notes, the amount of valid material is limited not only through the fact that articulated skeletons and skulls are rarely found in association but also because of the methods of early collectors, who plucked the skulls and neglected the skeletons.

A chapter on titanothere musculature, contributed by Dr. W. K. Gregory, follows. Dr. Gregory has pointed out that it is impossible fully to understand the skeleton of an animal without a proper appreciation of the muscles with which it is so intimately related. The present chapter is an illustration of the results to be obtained by this mode of attack. Using one of the common Oligocene forms as a type, the musculature, especially of the limbs and head, has been restored on the basis of careful comparative studies. Once the musculature is understood, the dry details of the skeleton become invested with new meaning. Logically following this, Chapter IX discusses the mechanics of locomotion in ungulates, the principles of leverage and muscular action and the significance of variations in the ratios of limb segments.

As in the case of the preceding sections, Chapter X goes far beyond the bounds of the titanotheres themselves in the treatment of their origin and ancestry. Following a discussion of the origin of the perissodactyls, an attempt is made to characterize a primitive perissodactyl, and the variations found in many structures are traced in all branches of the order. The facts concerning titanothere morphology presented in earlier chapters are reviewed with especial reference to their bearing on the adaptive radiation of the group.

In conclusion Professor Osborn treats of the causes of the evolution and extinction of the titanotheres. As to extinction, various reasons which have been suggested as responsible for the extermination of mammalian types are discussed, for the most part without the conclusion being reached that they have played any important rôle in the seemingly sudden disappearance of these strange animals. It is suggested, however, that a major factor may have been the fact that the teeth were inadaptive, lacking the possibility of becoming high crowned and thus permitting the titanotheres to take up the grazing habit which was rendered necessary by changed conditions.

It is only the paleontologist who has direct evidence as to the mode of evolution, and in consequence Professor Osborn's conclusions as to evolutionary processes, based upon an intensive study of titanothere phylogeny, merit serious consideration. He abandons the Lamarckian view-point held by Cope; selection is admitted as important. But to the mutation theory as held by the great majority of modern geneticists he takes objection. He holds that variations are not discontinuous and fortuitous, as the genetic evidence seems to show, but are orderly, determinate and generally adaptive. The initial appearance of new characters (rectigradations) are "timed" in the case, for example, of the rudiments of horns in various upper Eocene titanothere phyla, while in the case of changes in proportions (allometrons) "progressive brachycephaly and progressive dolichocephaly in the titanotheres point to the presence of some similarly acting influence affecting generation after generation in a similar manner." Reasoning from this evidence, he has reached his tetrakinetic theory of evolution. Germinal evolution is neither purely internal nor purely external, but a combination of the two; evolution is due to the interaction of the germinal material, the developing organism and the physical and biological environment.

While it does not seem improbable that the changes in proportions might be explained on the basis of mutation and selection, there appears to be considerable strength to Professor Osborn's argument when applied to such cases as the incidence of horns in titanotheres. The independent appearance of horn rudiments in related forms might be attributed to parallel mutations, such as have long been known to occur in various species of Drosophila; but it is difficult to see how there can have been the slightest survival value in the faint beginnings of these structures. It is unfortunate that at the time this section was written so little of the literature of modern genetics was available for discussion. However, the evidence shown for Professor Osborn's view-point by the titanotheres is fully presented in the monograph and is available for the consideration of any geneticist who may desire to attempt a Mendelian explanation.

A work of the magnitude of this monograph could not be the sole product of one man. Professor Osborn notes that Dr. Gregory has collaborated throughout in its preparation, and in the preface tribute is paid to the many colleagues and assistants who have aided in the work. The monograph is thus essentially a product of the department of vertebrate paleontology of the American Museum of Natural History; but viewed again in this light, it is again a personal triumph for

Professor Osborn. Founded less than four decades ago, the department has risen in that space of time to an unchallenged position of leadership in the field, while throughout the country there are few paleontologists who have not at some time or other been connected with this institution, few museums which have not been greatly influenced by the example set by the American Museum. The present monograph is a lasting monument to Professor Osborn's work in paleontology; but a still more enduring testimony to his labors for paleontology will be the American Museum's work and the inspiration it will continue to give to workers in the field of vertebrate history.

ALFRED S. ROMER

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE METHOD FOR THE GERMINATION OF OOSPORES OF SCLEROSPORA GRAMINICOLA

THE germination of oospores of *Sclerospora graminicola* has been a subject of interest since the time of Schroeter.[1] However, no one except Magnus[1] has succeeded in germinating oospores, prior to the writer's recent investigation.[2,3] In further studies in the department of plant pathology, University of Nebraska, a simple method for the successful germination of oospores has been devised. Briefly, the method consists of placing a layer of moistened cotton in the two parts of a Petri dish. Then a small piece of moist filter-paper on which small amounts of oospore powder are placed is put upon the surface of the moist cotton in such a way that the filter-paper will partly, but not entirely, touch the cotton. Both the cotton and filter-paper must be drained of excess moisture before the oospores are added to the dish. It is essential that the space between the two layers of cotton in the dish be about one half the height of the dish. Small blocks of 2 per cent. agar-agar, on which the oospores are scattered over the surface just as the agar is hardening, can be substituted for the filter-paper. One difficulty encountered when moist filter-paper is used is that the oospores on the periphery of the mass germinate earlier and better than those in the mass.

The time required for germination is markedly different at different temperatures. For instance, the time required for germinating at 35° C. is 22 to 40 hours; at 30° C., 24 to 45 hours; at 25° C., 30 to 48 hours; at 20° C., 42 to 60 hours; at 15° C., three to four and one half days, and at 10° C., nine to ten days. The percentage of germination, of course, varies with the temperature and also to a great extent with the source and age of the oospores. Therefore, it is advisable that oospores from different sources and ages be tested. Germination has been obtained within a range of 10° to 35° C. The optimum temperature appears to be near 20° C., although in previous experiments a higher optimum temperature over a short period of time was reported.[3]

[1] J. Schroeter, *Hedwigia*, 18: 83–87, 1879.

[2] M. Hiura, *Agriculture and Horticulture* (Japan), 4: 11–20, 1929.

[3] M. Hiura, *Jour. Plant Protect.* (Japan), 16, 5 pp., 1929.

MAKOTO HIURA

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A PRACTICAL FLAGELLA AND CAPSULE STAIN FOR BACTERIA

THE following method of flagella and capsule staining is offered as a contribution both to the teacher of bacteriology and to the technician in the laboratory. It is rapid, simple and dependable. It has been especially designed for staining *Bacillus proteus vulgaris* and *Bacillus subtilis*, common soil species, and the various members of the colon-typhoid group. The procedure is as follows.

(1) Make a thin smear of 15 to 24 hour agar growth of bacteria in a loopful of water on a clean slide. Air-dry. Do not heat. (2) Cover with mordant (5 per cent. tannic acid, 3 parts; 10 per cent. ferric chloride, 1 part) for two minutes. (3) Put seven drops of mordant in a small receptacle and add 1 drop of Ziehl-Neelsen carbol fuchsin stain. Mix. Add 1 drop of concentrated hydrochloric acid. Mix. Add 1 drop of concentrated formaldehyde. Mix. (4) Pour off mordant from slide and cover smear with the mixture prepared in (3). Apply seven minutes. (5) Wash smear in running water. (6) Cover with Ziehl-Neelsen carbol fuchsin stain (Basic fuchsin, 10 grams; ethyl alcohol, 95 per cent., 100 cc; phenol, 5 per cent. aqueous, 1000 cc) and *gently* steam for one half minute. (7) Remove stain with running water. (8) Blot and examine.

The following precautions are in order.

(*a*) Take only a minute portion of the agar growth. Do not use semidry agar. For best results add the agar growth to a drop of water on a slide, stir, and let stand for five minutes, permitting individual bacteria to become detached from the agar mass; then spread loopful on another slide and work with this second slide. (*b*) The mordant will keep indefinitely and so can be prepared in quantity. The mixture

prepared in (3) should be used fresh. (c) Filtered mordant and stain yield better preparations than unfiltered materials. (d) A small variation in ferric chloride content of mordant affects the depth of color of the flagella. (e) If a tube containing 2 cc of water be heavily inoculated with agar growth, it will supply hundreds of flagella smears over a period of two days.

The flagella stain described is a capsule stain as well. It stains the capsules of such organisms as *Diplococcus pneumoniae, Streptococcus fecalis* and Friedlander's bacillus when these are grown in broth. It also stains the capsules of pneumococci recovered from the peritoneal exudate of white mice. The following procedure is recommended for staining the exudate. (1) Spread a loopful of the exudate in a loopful of water on slide. Undiluted exudate may be used, omitting the water. (2) Apply mordant described in (2) for ten seconds. (3) Wash in running water. (4) Apply cold diluted carbol fuchsin stain for ten seconds. (5) Wash with water, blot and examine.

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SPECIAL ARTICLES

AN ATTEMPT TO PRODUCE MUTATIONS BY THE USE OF ELECTRICITY

THE calculations made recently by Muller and Mott-Smith[1] indicate that high frequency radiations are not the only cause of mutations. It is, therefore, desirable that a further search be made for other causes. On account of its wide distribution in nature, its wave properties and the fact that it travels at enormous speeds, electricity, and especially high frequency electricity, offers a good field for investigation in this connection.

Two tests have been conducted at the Agricultural and Mechanical College of Texas to determine whether or not mutations can be produced with electricity. The organism used in these experiments was *Drosophila melanogaster*. The well-known C1B method of Muller was adopted. It offers an excellent technique for studying any new agency as a possible causative factor in the production of mutations.

In the first experiment, which was conducted in 1928, the flies were treated in a field between two concentric copper cylinders. It was found necessary to cover one end of the opening with cheesecloth and to pass a strong current of air through the space between the cylinders to remove the gases produced by the electricity. Otherwise the flies were killed by the gases. The peak voltage was 33,000 volts at 60 cycles, giving a voltage gradient from 25,000 volts per cm at the surface of the inner cylinder to 7,000 volts per cm at the inner surface of the outer cylinder. Treatments for various lengths of time from one minute to thirty minutes were given.

The treatment had very obvious immediate effects on the flies. Some were killed. Those which were not killed were so affected that nearly all lost control of themselves. The legs usually became tangled. A fly so affected would lie on its side apparently trying to untangle its legs. Some of the flies recovered in a few minutes and became normal in their actions. Others required as long as twenty-four hours in which to recover their equilibrium. Still others died without ever becoming normal again. Some of those which did recover were sterile.

A total of 172 daughters of treated males were mated. Not a single case of a lethal mutation was observed.

The progeny of these females, that is, the F_2 generation from the treated flies, was examined in detail for visible effects. A white-eyed female was found in one of the cultures. This was not a contamination, because this fly was gray whereas the only stock of white-eyed flies in the laboratory at that time was yellow. Several peculiar variations in wing size and shape were noted. An example is the blister wing occurring as the left wing of one female. This wing stood out from the body, had six veins instead of the normal four and had a blistered or bubble-like area covering about one sixth of the wing.

These results were not conclusive in either direction. Enough effects were observed, however, to warrant the repetition of the experiment on a larger scale.

This was done in the spring of 1930. The adult males were treated this time in an electrostatic field of a potential equal to the breaking-down point of air, or 30,000 volts per cm, a total of 225,000 volts at a frequency of an oscillating current of 1,225,000 cycles per second. Care was taken to prevent the current from breaking over.

The flies were held in the field confined in small cheesecloth bags. An attempt was made to hold the flies in gelatin capsules while treating them. However, the current was observed to go around the capsule, hence the adoption of the cheesecloth bags.

One minute was the longest time it was found practical to expose the flies in this field. This is the length

[1] H. J. Muller and L. M. Mott-Smith, *Proc. Nat. Acad. Sci.*, 16: 277–285, 1930.

of treatment that was used. This treatment killed half the flies exposed to it and rendered still others useless for breeding.

Sixty-nine fertile matings were made with treated males. Ten ClB daughters from each male were mated in individual cultures, making 690 matings producing 100,000 flies which were observed for lethal mutations. In no case where large numbers of progeny were produced were any lethal mutations observed. Three matings showed no males, but each of these produced only two or three females, hence showed nothing significant.

Thus far the results are of such a nature as to indicate that very probably mutations can not be produced by the use of electricity, at least of the particular kinds used in these experiments.

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THE FECUNDITY OF THE OYSTER[1]

IT is a well-known fact that many marine invertebrates, especially those that discharge the eggs into the water where fertilization outside of the organism occurs, produce large numbers of sex cells during a spawning season. The estimation of the total number of eggs developed in a single female is of certain scientific interest, but unfortunately it presents considerable difficulties. In the case of the oyster, which is known to be extremely prolific, the attempts to determine the number of eggs produced by one adult female were made by Möbius[2] in 1883 and Brooks[3] in 1880. Möbius's method consisted in weighing first the whole mass of the embryos which were scraped by means of a small brush from the gills of the female, then in weighing and counting the number of embryos in a small portion of it. He estimated that the average number of embryos in each of five full-grown *Ostrea edulis* from Schleswig-Holstein was 1,012,955. This figure is less than that given by Eyton,[4] whose estimate was 1,800,000. Brooks estimated the number of eggs in the American oyster, *Ostrea virginica*, by determining the total volume of eggs washed out of the ovary and by measuring the dimensions of eggs. He arrived at the conclusion that an oyster of average size developed more than 9,000,000 eggs. An unusually large oyster, according to his computation, would possibly produce 60,000,000 eggs in one summer. Nelson[5] thinks that a large oyster, "if fat the preceding spring, undoubtedly would mature from 50,000,000 to 60,000,000 eggs in a season."

During the course of the experiments on the spawning of oysters in which the writer was engaged during last summer and fall opportunity presented itself to enumerate the eggs laid by *O. virginica* and *O. gigas*. Experiments with the American oysters were carried out at Woods Hole; those with the Japanese species (*O. gigas*) were made at the Hopkins Marine Station, Pacific Grove, California. Japanese oysters were shipped from Samish Bay, Puget Sound, to Pacific Grove where they were kept for about a month in the laboratory tanks. *Ostrea gigas* grows very well in Samish Bay, but in spite of good development of the gonads, fails to spawn there.

Female oysters, placed in twenty-liter glass tanks filled with sea water, were stimulated to spawn, and kymograph tracings of the spawning reaction, which is characterized by the rhythmical contraction of the adductor muscle, were obtained. After the reaction was over, the water in the tank was stirred with a powerful electric stirrer and a 100 cc sample was taken. Eggs, killed by addition of a few drops of 1 per cent. osmic acid, were counted, using the Sedgwick

NUMBER OF EGGS DISCHARGED AND DURATION OF SPAWNING REACTION OF *O. virginica* AND *O. gigas*

Oyster No.	Length cms	Width cms	Date 1929	Temp. °C.	Duration of reaction, minutes	Number of contractions	Average number of eggs per contraction, millions	Total number of eggs discharged in one spawning period, millions
O. virginica			July					
292	13.3	10.5	23	22.5	61	56	1.26	70.3
295	9.2	7.0	24	24.0	36	57	0.53	30.3
299	11.2	8.0	24	23.0	70	75	0.20	15.0
302	9.4	6.6	25	25.0	70	135	0.85	114.8
O. gigas			Oct.					
J-2	15.2	6.9	2	25.0	23	31	1.34	41.5
J-2	15.2	6.9	9	30.0	23	47	0.83	39.0
J-2	15.2	6.9	19	30.0	19	44	0.26	11.4
J-16	9.5	6.1	20	27.5	15	....	....	30.4
J-20-1*	11.6	6.8			59	121		
J-20-2*	10.9	6.2						
J-20-3*	11.2	6.8	22	25.3				55.8**
J-20-4*	12.0	4.8						
J-20-5*	10.8	7.4						

* Five females were kept together; kymograph tracing obtained from one oyster only.

** Average per female; total number discharged by five oysters, 278.8 millions.

[1] Published by permission of the U. S. Commissioner of Fisheries.

[2] K. Möbius, "The Oyster and Oyster Culture," Appendix H to the Report of the Commissioner of Fisheries for 1880, pp. 681–747, 1883.

[3] W. K. Brooks, "Development of the American Oyster," Johns Hopkins University, Studies from the Biological Laboratory, No. IV, p. 81, 1880.

[4] T. C. Eyton, "History of the Oyster and Oyster Fisheries," London, 1858. Quoted from Brooks, *loc. cit.*

[5] T. C. Nelson, "Aids to Successful Oyster Culture," New Jersey Agricultural Experiment Stations, 1921, Bulletin 351, p. 59, 1921.

Rafter method for enumeration of plankton organisms. Each time five samples were taken and the average was computed. The figures are accurate within ± 10 per cent. The results of the experiments are presented in the table.

An examination of the table shows that the number of eggs laid by the female *O. virginica* during one spawning period varied from 15 to 114.8 millions. Inasmuch as the author's experiments show that the female can be induced to spawn five or six times during the season it is permissible to assume that the number of eggs discharged during one spawning period represents only a fraction of their total number in the organism. It is quite probable that the maximum number of eggs in a single adult female may be close to one half of a billion. An examination made immediately after the spawning of oyster No. 302, which had discharged 114.8 millions eggs, has shown that the oyster still contained vast numbers of eggs, the thickness of the gonad layer being about 0.7 cm.

The number of eggs discharged during one spawning period by the Japanese oysters varied from 11.4 to 55.8 millions. The last figure represents the average number of eggs discharged by five oysters used in the experiment J-20. It was noticed, however, that during this experiment the four oysters which were in the tank together with the oyster No. J-20-1 contributed but a very small portion of eggs, probably not more than one fifth of their total number. Oyster No. J-2, which was induced to spawn three times on October 2, 9 and 19, discharged altogether 91.9 millions of eggs.

The results of the experiments with two species of oyster show that the actual number of eggs developed each summer by the female oyster is much greater than was previously estimated by Brooks.

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THE OIL ABSORPTION OF SHELL EGGS

SHRINKAGE, due to the loss of carbon dioxide and moisture, is the greatest economic factor encountered in the cold storage of shell eggs. The following is a brief preliminary report of work done in the food research division of the Bureau of Chemistry and Soils on the problem of reducing shrinkage, by the use of mineral oils.

Eggs were dipped in oil, some at atmospheric pressure, others under a vacuum. To facilitate macroscopic observation of penetration, the mineral oils used were colored with Sudan IV, an oil-soluble dye. Penetration was particularly noticeable around the air cells.

Soxhlet ether extractions of shells and membranes were made to determine quantitatively the oil absorbed by the shells and by the membranes. The normal quantity of ether-soluble extract in unoiled shells and membranes was found to be approximately 1 per cent. The normal quantity of fat in the membranes of unoiled eggs was found to be from 3 to 4 per cent. and in the shells (freed of membranes) less than 0.1 per cent. (Percentage was based on weights of individual samples.)

Eggs dipped in oil at atmospheric pressure for 2 minutes were found to contain approximately 10 times more ether-soluble extract in the combined shells and membranes than did the untreated eggs. The quantity of ether-soluble extract in the membranes, however, was found to be only slightly greater in the treated eggs than in the untreated eggs.

No difference in the quantity of absorption was found between the shells and membranes of brown eggs and those of white eggs.

Eggs dipped under a vacuum of 50 mm for 1 minute were found to contain approximately 13 times more oil than the untreated eggs. The quantity of ether extract in the shells of these eggs was found to be about 7 times greater than in untreated eggs and approximately the same as in the shells of eggs dipped at room pressure. The quantity of ether extract in the membranes was found to be approximately 5 times greater than in the membranes of untreated eggs and 4 times greater than in those dipped at atmospheric pressure.

Unoiled eggs, as well as eggs dipped in oil both at ordinary atmospheric pressure and under vacuum, were stored at 98° F. for 10 days, and weighed at 48-hour intervals for the detection of shrinkage. The unoiled eggs lost about 13 per cent. of their total weight in 10 days. Those dipped at atmospheric pressure in plain colored oil at 100° F. for 2 minutes lost approximately 2 per cent. of their weight. Eggs dipped in 2 per cent. aluminum soap oil under 50 mm of vacuum at 100° F. for 1 minute and stored at 98° F. for 10 days lost only 0.5 per cent. Almy, Hepburn and Macomber[1] reported that eggs dipped in oil containing 2 per cent. aluminum soap and stored at 40° C. for 12 days lost 6.2 per cent. of their weight.

These studies on the oil treatment of eggs are being continued.

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[1] L. H. Almy, H. I. Macomber and J. S. Hepburn, "A Study of Methods of Minimizing Shrinkage in Shell Eggs During Storage," *J. Ind. Eng. Chem.*, 14: 525, 1922.

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THE DEVELOPMENT OF VIEWS REGARDING THE NATURE OF CHEMICAL FORCES[1]

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AT the beginning of my lectures before the department of chemistry of Cornell University, I wish to express my great pleasure at having the opportunity to spend a few months in this wonderful laboratory, beautifully situated on a knoll of the picturesque campus, and to come into close personal contact with my distinguished colleagues as well as with the students. I am sure to learn many things from the splendid organization of this department which will be of great use in my own institute. I thank Professor Dennis heartily for the honor of his invitation to the George Fisher Baker Non-resident Lectureship and for the opportunities he thus affords me.

It is a pleasant custom that the holder of this lectureship begins his activities with a general address for a wider circle of listeners than will attend his later lectures in his special field. Several of my predecessors have chosen for this introductory lecture subjects that were more or less far removed from the particular lines of their own research. If you will permit me, I will join the other group and discuss a problem which lies in my own field, for I regard the problem of chemical forces as one that may be of interest not alone to the specialist but to the general public as well. These forces affect deeply not only the surrounding, inanimate world but also the life processes within our own organism, and I shall endeavor to present to you the problem of their true nature.

This question has greatly interested theorists for many centuries. Let me briefly recount at least a few of the steps in the older development before I pass on to the discussion of the views that are held at the present time. There is a characteristic trend that has been common to most of the various theories which have arisen. Chemistry, as you know, serves as a

[1] Introductory public lecture.

basis of many other sciences, such as mineralogy, crystallography and biology, and chemistry in turn rests in many respects upon the results obtained in physics. And we shall see that the views concerning the nature of chemical forces in the passage of time often have been modified and shaped by the physical theories of the moment.

In the seventeenth century there was great development in the field of mechanics. It is necessary to mention only the names of Galileo, Kepler and Newton to make clear the powerful influence that mechanics exerted upon the concepts of that period. Even a century later, explanations of phenomena were expected to be based upon mechanical processes. As early as the seventeenth century the French chemist Lemery, in an attempt to explain the action of an acid on a metal, sought for a mechanism upon which its chemism might be based.

The sensation of taste that is produced by acids can be described as biting or prickling, and it was quite natural, from the point of view of a crude mechanical concept, that when a metal is dissolved by an acid the small particles of the acid were assumed to possess a pointed form which would bore into the cavities of the metal. Naturally such a concept can not be recognized as a sound scientific theory. In general the mechanical ideas have not proved to be fruitful in explaining chemical phenomena. To enable the particles of an acid to act upon a piece of metal, the particles of acid dissolved in water must by virtue of their motion in the liquid come into the immediate neighborhood of the metal. Thus far, the process can be clearly conceived as mechanical, but the real chemism begins only when the reacting particles of the acid and metal collide with one another, and at this point the bridge to the usual mechanical explanation is lacking.

It is interesting to note, however, that to-day mechanics is again beginning to come into closer relationship with what is essentially chemical action. This newer view is based not upon the classical mechanics of the seventeenth and eighteenth centuries, but on the refined, modern theory of wave mechanics or quantum mechanics associated with the names of de Broglie, Heisenberg and Schrödinger. We must, however, ascend through several stages to pass from the mechanical chemistry of a Lemery to this latest view.

When we leave the field of mechanics we enter at once another branch of physics, electricity, which we must consider if we are to understand the views advanced by the great Swedish chemist Berzelius in the early part of the nineteenth century. By that time two fields of knowledge had been developed that are of permanent value for our problem. There was brought forward a more exact conception of the building up of substances from small particles, an idea familiar to the Greeks. Dalton developed the atomic theory which required the existence of as many different atoms as there are non-decomposable elements, the smallest particle of a chemical compound, the molecule, being composed of one or more elemental atoms. The question at once arose: What forces hold these atoms together in the molecule?

The answer to this question appeared to be brought nearer because, in this period, it was found possible to overcome these attracting forces by means of a new and powerful agent, the electric current. At the end of the eighteenth and the beginning of the nineteenth centuries there appeared the epoch-making discoveries of Galvani and Volta as to the manner of producing an electric current. With the aid of the current, Davy was able to bring about sensational chemical reactions such as the separation of caustic soda into metallic sodium and oxygen. This was a decomposition of a chemical compound into its elements, a splitting of a molecule into atoms with the help of electricity.

Analysis of this phenomenon of electrolysis seemed to indicate a close relationship between electricity and the various kinds of atoms. Distinction had long been made between positive and negative electricity, and the new discoveries by Davy and others indicated that many elements, such as the metals and hydrogen, behaved during electrolysis as if their atoms carried positive charges, while the atoms of chlorine, oxygen and similar elements seemed to be negatively charged. But positive and negative electricity exert an attractive force upon each other, while charges of the same sign repel each other. This brought Berzelius to the idea that the chemical force which binds the oxygen atom either to the sodium atom in an alkali or to the hydrogen atom in the water molecule is of an electrical nature and is dependent simply upon the attraction of oppositely charged atoms as represented by the following slightly modernized formulas:

Berzelius (1812)

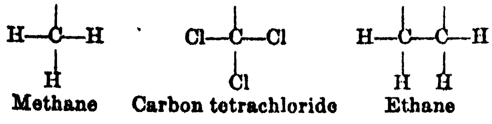
$$\overset{+}{Na_2}\overset{-}{O},\ \overset{+}{Na}\overset{-}{Cl},\ \overset{+}{H_2}\overset{-}{O}$$

This conception of the electrostatic nature of chemical forces Berzelius sought to extend to all chemical substances. He held that each atom contained an excess of either positive or negative electricity, and that because of this fact an atom is able to combine with oppositely charged atoms. Indeed, this electrostatic theory of Berzelius seemed to be satisfactory in explaining the behavior of many substances, and it was used by chemists as long as their researches were limited chiefly to inorganic compounds. But about the middle of the nineteenth century a new branch of

chemistry blossomed into life—organic chemistry. This concerned itself with the substances found in animate nature, compounds whose most important constituent is carbon. Among the simplest of such compounds we have methane (CH_4) and carbon tetrachloride (CCl_4). Both these substances are stable compounds in which the atoms are held together by strong forces. If now one endeavors to explain these attractive forces on the basis of the theory of Berzelius, contradiction concerning the charge on the carbon atom immediately appears. According to the evidence furnished by the electrolysis of inorganic compounds, hydrogen is positively charged, from which it follows that the carbon atom in CH_4 should carry a negative charge. Yet in CCl_4, since chlorine is shown by electrolytic experiment to be negatively charged, the carbon atom should have a positive charge. Such contradictions, which arose in many analogous cases, led to the conviction that the electrostatic theory of Berzelius was untenable, and therefore chemists gradually abandoned it. We shall see later that this theory did nevertheless contain a germ of truth.

In order properly to follow the historical development of the subject, however, we must now leave the field of physics and turn our attention to a theory that forgoes definite assertion concerning the physical nature of chemical forces and contents itself with a formal representation of the union of atoms in molecules. I refer to the valence theory advanced in 1857 by the German chemist Kekulé. Kekulé represented the union of the atoms in the molecule by means of lines, the maximum number of other atoms with which a given atom may combine being represented by the number of lines proceeding from it. This number is termed the valence of the atom. The carbon atom has a valence of four, the atom of hydrogen and that of chlorine in carbon tetrachloride each has a valence of one.

Kekulé (1857)



Methane Carbon tetrachloride Ethane

It is a strikingly primitive picture that is used here to represent the chemical forces, and yet it confirms in most convincing manner the truth of Goethe's words, *In der Beschränkung zeigt sich erst der Meister*, for the scheme of Kekulé has proved to be extremely fruitful in chemical research up to the present day, and in particular in the field of the chemistry of the compounds of carbon. We find in almost every case that the carbon atom possesses four of such valence forces, four units of chemical attraction each of which is able to seize and hold an atom. The constancy of this number 4 in most of the carbon compounds constitutes the great, although purely systematic, value of Kekulé's suggestion.

From the physical view-point Kekulé's theory stands in some contradiction to that of Berzelius. On the basis of the Berzelius theory one can also draw lines between the atoms that he regarded as oppositely charged and as electrostatically bound. Such connecting lines would then have a positive and a negative end. One positive atom can be replaced only by a positive atom. The link would be polar. According to Kekulé, on the other hand, atoms of widely varying nature can be attached to the outer ends of the valence forces emanating from the atoms of carbon, and this stands in agreement with the facts of organic chemistry. Thus the carbon atom may attach itself to other carbon atoms, as is shown in the above formula of ethane. The linkage is here non-polar. Specially convincing illustrations of the existence of such non-polar linkages are found in the molecules of certain elements: the molecule of ordinary gaseous hydrogen (H—H) and also the molecule of chlorine (Cl—Cl) are each composed of two atoms. In such molecules there is no reason to assume that one atom carries a positive and the other a negative charge. The above successful application of Kekulé's scheme to inorganic molecules also seemed to justify its use for representing such compounds as sodium chloride, for which the theory of Berzelius seemed to be quite satisfactory. Until recently this has been written as Na–Cl without endeavoring to bring out the opposite polar character of sodium and chlorine as revealed by electrolysis. As may so often be observed in the history of the development of scientific theories, a leap from one extreme to the other here took place. Both theories attempted to reach the same goal and to explain the linkages of the atoms in all substances in a uniform manner. Further developments, however, showed that this could not be achieved in so simple a way.

In the last decade of the past century there appeared a new branch of chemistry, physical chemistry, associated with the older branches, inorganic and organic chemistry. The difference between physical chemistry and these two older divisions does not lie in the nature of the substances that are employed in the sphere of its investigations, for it concerns itself both with inorganic and organic compounds. However, the method of research used in physical chemistry, which was indeed only partially novel, lays particular emphasis upon the study of chemical compounds and reactions from the standpoint of physics. The electric current was again invoked for the inves-

tigation of the behavior of substances but not alone for the purpose of effecting chemical decomposition. The question as to whether various substances when dissolved in water are capable of conducting the electric current was very carefully studied and striking differences were found to exist. Aqueous solutions of compounds such as ordinary salt conduct the electric current very well. In order that conduction of the current may take place, however, charged particles must be present. It was Arrhenius who, in the year 1887, brought forward the theory, at that time regarded as extremely bold, that in such a solution of salt the molecule NaCl decomposes into a positively charged sodium atom and a negatively charged chlorine atom, the so-called ions. This concept of Arrhenius may to-day be regarded as fully verified. From this it would follow that when a solution of salt is evaporated and the water is removed the ions are brought closer together from the relatively greater distances that existed between them in solution, and the electrostatic forces between them must become active in some manner, since according to Coulomb's law the intensity of the electrostatic force is inversely proportional to the square of the distance between the charges. On the other hand, a substance like H_2 in aqueous solution does not conduct the current to any noticeable extent and consequently there is no reason for assuming the existence of ions of hydrogen in this solution.

These facts have led us since the beginning of this century (Abegg, Nernst) to distinguish between two different kinds of chemical linkages: on the one hand the polar linkage, also termed hetero-polar or dualistic linkage, which is characteristic of salts, and on the other hand the non-polar, homo-polar or unitary linkage, which is characteristic of the molecules of elements and of many organic compounds. And thus we can understand why the dualistic theory of Berzelius could maintain itself only so long as the investigation of organic compounds was not the center of interest. However, the unitary theory of Kekulé which replaced that of Berzelius also does not satisfactorily explain all the phenomena with which we have become acquainted. Both theories are entitled to exist side by side.

The theory of Berzelius in its original form was very weak in one respect; it assumed, for example, that the sodium atom and the chlorine atom always carry an excess either of positive or negative electricity. This, however, is not in agreement with the facts, for metallic sodium as well as its free atom in sodium vapor under normal conditions is electrically neutral. The same holds true for chlorine. The question arises, therefore, as to the manner in which the positively charged sodium ion and the negatively charged chlorine ion present in the solution are formed from these neutral atoms.

A satisfactory answer to this question was possible only after we had obtained a deeper insight into the nature of the atom itself and had acquired the knowledge that the atoms of the elements are not really the indivisible building-stones from which the material world is constructed. Physical research which began with the investigation of cathode rays and the rays from radioactive substances, and with which the names of Lenard, J. J. Thomson and Rutherford are intimately connected, revealed that the atoms of all elements are themselves composite structures and are in the last analysis made up of positive and negative electricity. These electrical charges have an atomistic structure; the magnitude of the smallest charge, the elementary electrical quantum, was measured by your countryman, Millikan, in his brilliant investigations. The charges of these elementary quantities of positive and negative electricity are equal and differ only in sign.

According to the Rutherford-Bohr theories of atomic structure, the atoms of all elements are composed of these atoms of positive and negative electricity. The simplest and lightest element, hydrogen, contains in its neutral condition one elementary quantum of positive electricity and one of negative electricity. The two do not, however, play precisely the same rôle, because their masses are not the same. The elementary negative charge, termed an electron, possesses a mass only 1/1830 that of the total mass of a hydrogen atom. The remainder of the mass lies in the positive charge. The lighter electron revolves around the heavy, positively charged nucleus of the hydrogen atom, the proton, and because of this fact the two attracting charges do not fall together but remain at a definite distance from each other, as do the sun and its planets.

When we consider the heavier atoms we find that they also contain a positively charged nucleus, whose charge, however, varies from element to element and always is a whole-numbered multiple of the elementary quantity, *e.g.*, 11 for the sodium atom, 17 for that of chlorine. These nuclei have dimensions which are very small compared to the dimensions of the whole atom even in the case of the heaviest atoms. The negative charge in the heavier atoms is divided among a corresponding number of negative electrons, and this number in the neutral state is therefore 11 for sodium and 17 for chlorine. All these electrons move in more or less complicated paths around the nucleus.

How now are the ions formed from such neutral atoms? Since, as has been mentioned, a positive elementary charge carries practically the whole mass of

a hydrogen atom and such positive charges are localized in the nucleus of the heavier atoms, the removal of one or more positive charges from an atom would deeply affect its internal constitution and would mean a conversion of one element into another such as we have actually observed in the radioactive processes. The chemical processes, as well as the formation of ions from neutral atoms, take place only in the outer sphere of the atom, in the electron shells. A positive ion is formed when one or more electrons are removed from a neutral atom, for then the positive charge of the nucleus will exceed the total negative charge by the number of negative electrons removed. Negatively charged ions are obtained by attaching one or more electrons to a neutral atom. The process of forming a molecule of the sodium chloride type from neutral atoms is therefore most simply understood by assuming that an electron is removed from a sodium atom and attached to a chlorine atom; the electrostatic attraction of the resulting positive and negative ions then unites them into a molecule or, if they are present in larger number, into a crystal of the salt.[2] This is the essential content of the electrostatic theory of polar linkage outlined by J. J. Thomson in 1904 and especially developed by Kossel in 1916. It represents the modernization of the Berzelius theory.

As far as the other type of linkage is concerned, we are indebted to the idea of Niels Bohr, which shows how it can be brought about by the electrical interaction of positive and negative charges in the atom without the necessity of assuming oppositely charged ions in such molecules and crystals. Let us consider the simplest non-polar molecule, that of hydrogen. It contains two atoms of hydrogen, and accordingly, two positive nuclei and two negative electrons. The mechanism for its constitution (see Fig. 2a) suggested by Bohr, was as follows. The two electrons move along a path whose plane is perpendicular to the line joining the two nuclei. The positive nuclei are held together by the negative electrons, which draw them toward the middle even though the positive nuclei mutually repel each other.

This model has not proved satisfactory from the quantitative point of view, and it is now assumed that the true structure of the hydrogen molecule approximates more closely that shown in a model designed by Heitler and London (1927) on the basis of the wave mechanics referred to at the beginning of this lecture. According to this newer view, the electrons perform such complicated motions within the atoms and the molecules that, in the course of time, an electron passes through every point of the space occupied by the atom or molecule, although the probability that an electron will arrive at any given point depends upon the distance of the point from the nuclei. Therefore, it is only possible to indicate a time average of the spatial distribution of the negative electricity. From the results obtained in this direction, it is particularly important for the discussion that is to follow, that this distribution of the negative electricity with reference to the nuclei of the two linked hydrogen atoms be quite identical, and in this respect the wave mechanics model and that in Fig. 2a are in perfect agreement. In both models also each of the electrons is, in fact, as often at a given distance from the one nucleus as it is from the other.

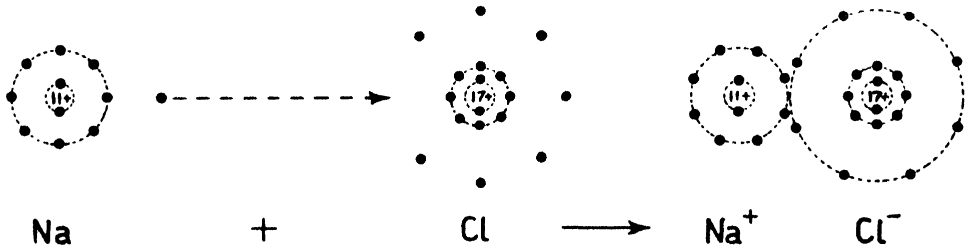


Fig. 1

[2] Of great interest in this connection is the fact that both ions contain eight electrons in the outermost shell, like the rare gases neon and argon.

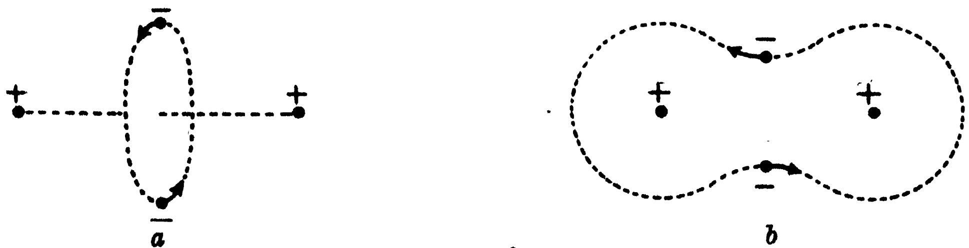


Fig. 2

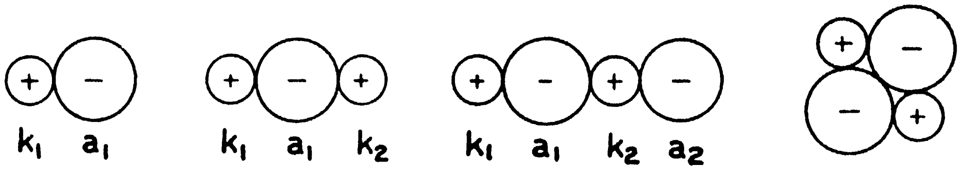
The relation between nuclei and electrons in the new model may be represented in a simplified way, sufficient for our purpose, by considering that the two electrons describe a path around the two nuclei, as indicated in Fig. 2b, and as has been assumed by a number of investigators in the past, particularly by Knorr (1923). The characteristic point common to all models proposed is, then: the linkage is effected by two electrons which are shared by both atoms in an identical manner. Here there is actually no polar contrast between the two bound atoms, and each contributes one electron to the linkage.

As has been shown very successfully by your countrymen, Lewis and Langmuir, this principle is also applicable to the molecules of other elements and to many other non-polar compounds. The general principle is, as a comparison of the following formulas with those of Kekulé shows, that two electrons held in common by the two atoms are associated with each one of Kekulé's valence lines—hence the term covalent linkage in contrast to ionic linkage.

G. N. Lewis (1916)

H	Cl	H H
H : C : H	Cl : C : Cl	H : C : C : H
H	Cl	H H
Methane	Carbon tetrachloride	Ethane

The chemical and physical behavior of both types of compounds stands in good agreement with the above conceptions of their structure. We will mention here three properties: the type of lattice in which the substance crystallizes; the ease with which it passes from the solid or liquid to the gaseous state, *i.e.*, its volatility and the ability to form ions in aqueous solution and therefore to conduct the electric current. In this respect extremely large differences may be mentioned between the typical representatives of the two classes of compounds (see Table I). Rocksalt can be vaporized under ordinary pressure only at 1440°. Hydrogen, however, is a gas at ordinary temperatures and must be cooled to −253° to liquefy it. In solution the former decomposes to a large extent into ions, whereas the latter remains as the molecule H_2 unchanged. The tendency to go over from the solid or liquid states to the vapor or gaseous state and *vice versa* is dependent upon the strength of the forces between the molecules. The attractive forces between the molecules of NaCl must, obviously, be much greater than those between the molecules of H_2. Indeed, even though the molecule NaCl is electrically neutral as a whole, it exerts, as the schematic representation in Fig. 3 indicates, a considerable electrical effect in its immediate neighborhood, because in this molecule the centers of gravity of the positive and negative charges, two poles (Fig. 3a), are separated. If one brings a positive ion k_2 to such a structure, which one calls a dipole, it will be attracted to the negative ion in the position which is indicated in Fig. 3b. The attractive force between the opposite charges a_1 and k_2 is greater than the repulsive force between the like charges of k_1 and k_2, because the distance between the former is but one half that between the latter. And if, in turn, one now adds the negative ion a_2 (Fig. 3c) it will, for the same reason, be attracted by the positive ion k_2 more strongly than it will be repelled from the negative ion a_1. Furthermore, there is a definite, although weak, additional attractive force exerted upon a_2 by the positive ion k_1. What we have before us is equivalent to the adhesion of two such neutral molecules, k_1a_1 and k_2a_2, as a result of electrostatic forces which are completely comparable with those which effect the cohesion of the ions within the molecule. Something entirely analogous holds for the action in the other two directions of space (Fig. 3d), and this explains, as shown by Kossel, the great tendency of the molecules of such salts to group themselves in large complexes and to form liquids and crystals. The validity of this view is attested by the recent determinations of the position of atoms and ions within such crystals by means of X-ray analysis. In Fig. 4 is portrayed the crystal structure of rocksalt. The individual points show the positions of alternate, positively charged sodium ions and negatively charged chlorine ions in a minute part of such a crystal. Each ion within the crystal is surrounded by six oppositely charged ions, all at exactly the same distance from the former. The electrical attractive forces existing between neighboring ions are equal in all three directions of space, so that it is not possible to regard any two ions as forming a molecule. Such a lattice therefore is called a coordination lattice. Similar relationships hold for many other salts. (See footnote 3.)



a *b* *c* *d*

FIG. 3

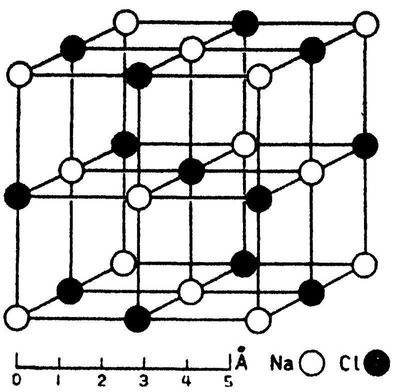


FIG. 4

The circumstances are entirely different in the case of H_2. Here the centers of gravity of the positive and negative charges coincide, so that as long as no shift of the charges takes place in the molecule, no electrical forces can be exerted on the outside. Hence, there is but a slight tendency for the H_2 molecules to combine with one another to form a liquid or solid. And there can be no doubt that the crystal structure of solid hydrogen is quite different from that of rock-salt. Corresponding to the very strong forces between two hydrogen atoms within the molecule and the very weak forces between distinct molecules, the distances between the atoms belonging to different molecules must be considerably greater than between those within one molecule, as indicated in the dia-

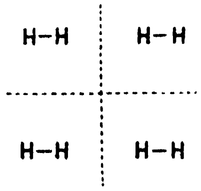


FIG. 5

gram (Fig. 5). Here we have individual molecules in the crystal lattice, and therefore we term it a molecule lattice.

Finally, the great difference between NaCl and H_2 with respect to the third property as given in Table I, *viz.*, the degree of their ionizations in aqueous solution, is readily understood without special discussion. Indeed, in the case of NaCl, the molecule and the crystal already contain ions and they need only to be separated by the action of the forces between the water and the ions, while in the case of such non-polar substances as H_2 energy first must be expended in order to form ions by shifting electrons to one of the atoms.

In such cases as that of sodium chloride and hydrogen, the relations are obviously quite clear. There is here not the least doubt concerning the group to which we must assign the substance, the ionic or the covalent non-polar type of compounds or linkages.

TABLE I

	Ionic linkage	Non-polar linkage	Transition type
	$\overset{+}{Na}\,\overset{-}{Cl}$	H : H	I Hg I
Type of lattice	Ionic coordination lattice	Molecule lattice	Layer lattice
Boiling-point at 760 mm ...	1440°	– 253°	351°
Degree of ionization in aqueous solution	high	zero	very low

It is immaterial whether we choose as our criterion the volatility, the type of lattice or the ability to dissociate in solution. The same holds for many other substances, and there is a wide-spread tendency to classify all substances under one or the other of these two types of linkages. However, there is a very large number of compounds for which this classification is so indefinitely indicated that it is impossible to apply it with any certainty, and naturally one finds differences of opinion regarding the type of structure to which they really belong.

An example is afforded by mercuric iodide, whose behavior with reference to volatility, crystal structure and ionization in solution is intermediate between that of hydrogen and that of sodium chloride. Mercuric iodide is solid at ordinary temperatures but boils at 351°, and may be vaporized with relative ease similarly to the closely related mercuric chloride, popularly termed corrosive sublimate. Both compounds have a low solubility in water as compared with sodium chloride and, what is here of particular importance, their degree of ionization is measurable but very small.

Of particular interest is the structure of the crystal lattice of mercuric iodide (see Fig. 6a). The characteristics of this lattice that are essential to our problem are emphasized in Fig. 6b which is a simplified presentation in one plane. It is seen that the two kinds of atoms are arranged in alternating layers —hence the type name proposed for it by Hund, "layer lattice." Just as in the lattice of sodium chloride, and in contrast to a molecule lattice, no individual molecule HgI_2 can be differentiated here. Each Hg is linked in an identical way with four, not with two I's; and each I is linked, not with one but with two Hg's. In another respect, however, this layer lattice recalls a molecule lattice more than it does an ionic coordination lattice. In the latter each ion has attracted for its immediate neighbors, on every

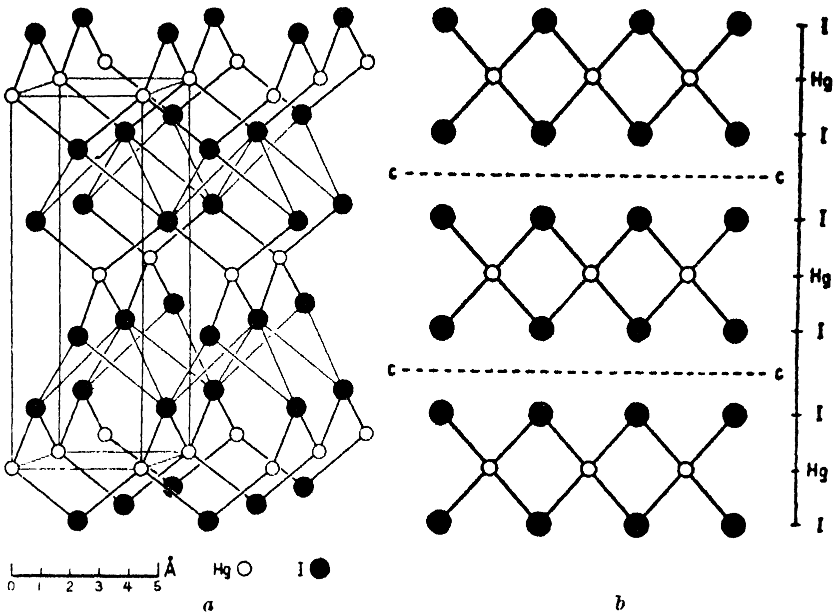


FIG. 6

side, only ions of opposite charge.[3] In the lattice of mercuric iodide, on the other hand, the layer sequence I, Hg, I is followed by I again, the intervals between two neighboring I-layers being greater than that between an Hg- and its neighboring I-layer. Obviously the attractive forces acting between two neighboring, similar layers must be different, and in fact they are weaker than those acting between two unlike layers, just as the forces between the molecules of H_2 are weaker than the forces within H_2. These weaker forces in the lattice cause the cleavability along the planes c-c (Fig. 6b) and, to some extent, the volatility of such crystals.

It is thus evident that none of the three properties mentioned in Table I permits one definitely to decide whether mercuric iodide should be classified as a polar or a non-polar compound. It behaves in an intermediate manner.

The difficulty of classification here encountered is, in the speaker's opinion, inherent in the method of classification itself. The Berzelius theory has failed by reason of its attempt to apply to all substances the same structural principle. It is, moreover, impossible, as we have seen, to understand satisfactorily the behavior of all substances from the view-point of the unitary concept. But classification into two sharply divided groups also is too narrow to explain satisfactorily all the facts. The distinction between the two types of structure mentioned probably will retain its fundamental significance for all time, but it is the speaker's conviction that one should regard them rather as limiting types between which it is possible to have a series of transition forms into which indeed many known substances can be fitted. The limiting case of non-polar linkage is found in the quite symmetrically built molecules: hydrogen, H_2, or chlorine, Cl_2. The other limiting case, the ideal ionic linkage, would be obtained if free positive and negative ions, formed by complete transfer of one or more electrons from one kind of atom to another—as from sodium to chlorine—could be associated with each other as rigid spheres without mutual influence. Real molecules and crystals approximate this limiting case only to a greater or lesser degree, for when two such ions come together a certain change always occurs, a deformation of the ions themselves.

The existence of such deformations can clearly be demonstrated in the case of the formation of mercuric iodide from its ions Hg^{++} and I^-. Aqueous solutions of mercuric nitrate and potassium iodide, containing these ions, are colorless. When these solutions are brought together the ions combine, yielding the intensely red mercuric iodide. This change of color indicates an alteration in the properties of the ions, namely, in the state of their electronic systems. Closer considerations show that in most cases where ions combine to form molecules and crystals it is specially the electronic system of the anion that is changed by the attractive force of the positive charge of the cation. The electronic system of the anion is drawn toward the cation, and thus the transfer of the negative electricity from the one kind of atoms

[3] This holds for any typical ionic lattice, not only for compounds of monovalent elements, such as NaCl (six neighbors each), CsCl (eight neighbors), but also, *e.g.*, for the lattice of fluorite (CaF_2), where each Ca^{++} has eight F^- and each F^- has four Ca^{++} as its neighbors.

to the other during the formation of the ions is reversed to some extent. This deformation (polarization) of the anion indicated in Fig. 7b and c thus leads to a diminution in the polarity of the compound. The degree of this deformation varies greatly in different cases and is, *e.g.*, in Fig. 7, greater in c than in b. It is therefore possible to conceive of an extended series of transition cases between the two limiting types of chemical linkage: one in which the ions are to be considered as rigid spheres which undergo practically no change when combining to form molecules (Fig. 7a), the other in which the electrons of the anions are so strongly drawn toward the cation as to become symmetrically disposed about the two nuclei (Fig. 7d). This latter case would be realized if a negatively charged hydrogen ion, H^-, composed of one proton and two electrons were to combine with a positive hydrogen ion, H^+, consisting of a single proton. This would yield the perfectly symmetrical hydrogen molecule, H_2, in which the two electrons are shared quite equally by both nuclei.

the ideal ionic linkage than does sodium chloride, because I^- is much more easily deformable than Cl^-, as refractometric data show, and because Hg^{++} has twice the charge of Na^+. The most important factor in this case is that Na^+ has the structure of neon (eight electrons in the outermost shell, Fig. 1) but Hg^{++} has no rare-gas structure (eighteen outermost electrons). To the intense deformation of the iodine ion by the mercuric ion is due the transition type of mercuric iodide.

Though the classification loses much in simplicity through the presence of these transition types, by taking account of them we attain a single system satisfactory for widely different substances which the dualistic and unitary theories attempted in vain.

I realize that the subject which I have discussed is a difficult one to present to a general audience, and I can only hope that I may have succeeded in giving you some idea of how scientists have attacked this problem of the nature of chemical forces, and of the conclusions which they have reached.

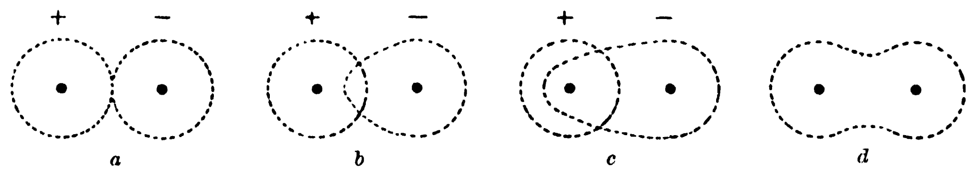


FIG. 7

In general, as was pointed out by the speaker and confirmed by Grimm, extensive experimental material shows that the degree of deformation of the anions increases and the character of the linkage in a molecule or a lattice departs further from the ideal ionic linkage and approaches more closely the non-polar type, the smaller the cation, the higher its charge and the greater the deformability of the anion. Other things remaining the same, in those compounds whose cations lack the character of rare gases the degree of deformation of the anion is greater and the compounds approach more closely the non-polar limit than in the case of those having cations of the rare-gas type. Mercuric iodide stands much farther from

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SCIENTIFIC EVENTS

HISTORIC APPARATUS[1]

THE Institute of Physics a short time ago appointed a committee to inquire into the possibility of drawing up a catalogue of apparatus which had been used in the course of investigations leading to important discoveries. At the request of the committee the institute is now making a general appeal to all who have charge of historic apparatus. The appeal, which is signed by Dr. W. H. Eccles, Sir F. W. Dyson, Sir W. H. Bragg, Sir C. A. Parsons, Sir J. J. Thomson, Sir R. T. Glazebrook and Sir H. G. Lyons, is made with the object of obtaining information as to the existence of apparatus and the researches it was used in, so that students of the history of science may be able to visit, identify and study it. It is also suggested that the committee could possibly assist the owners, if they so desire, to place the apparatus where it could be per-

[1] From *Nature*.

manently secured to the nation. In such institutions as the Science Museum, the Conservatoire des Arts et Métiers, the Deutsches Museum and the Smithsonian Institution, England, France, Germany and America already possess extensive collections of great value, and there are probably few observatories, laboratories or scientific societies which do not own some historic apparatus, while other instruments are in private hands. Practically every private collection, however, is ultimately dispersed, and the compilation of such a catalogue as that now being formed might lead to the more historic apparatus becoming the nation's property. As with pictures and other works of art, the selective principle should be applied, and a joint committee of the Institute of Physics and kindred societies would be a suitable body to act in an advisory capacity.

In the past, wars, riots and fires have been the cause of the destruction of much valuable apparatus. Gilbert's collection, which he bequeathed to the Royal College of Physicians, was lost in the Great Fire of London; Hevelius lost both observatory and instruments by a fire at Danzig in 1679; the great fire at Copenhagen in 1728 led to the destruction of Römer's telescopes, and the first observatory at St. Petersburg was burnt down in 1747. One of the most deplorable of all losses was occasioned by the fire at the Volta Centenary Exhibition at Como in 1900, when Volta's original piles and cells, etc., were lost. Wars have been no less destructive than fires. The manuscripts of Thomas Harriott, astronomer and mathematician, disappeared during the Civil War; Gregory Saint-Vincent, the seventeenth century geometer, lost all in the siege of Prague; Chladni lost some of his acoustical apparatus during the Napoleonic Wars, while Regnault, after the occupation of Paris by the Germans, returned to his laboratory at Sèvres to find his standard apparatus and the results of his great researches on the expansion of gases ruined. The destruction of Priestley's library and apparatus occurred during the Birmingham Riots of 1791. How important instruments may disappear unrecorded is shown by the case of Sturgeon's electrical apparatus. In 1825 the Royal Society of Arts recorded the award of a medal and thirty guineas to Sturgeon for the gift of his electromagnetic apparatus, but this, including the first electromagnet ever made, has unfortunately long since disappeared. Such, it may be hoped, will not happen to any important collection in the future, and we feel that the Institute of Physics is doing a public service in obtaining records which should go far to prevent such losses from happening.

BRITISH AIR ROUTE TO THE ARCTIC REGIONS

WITH the object of establishing an Arctic air route from Great Britain to Canada an expedition of British scientific men will, according to a wireless despatch to the New York *Times*, make the journey in Sir Ernest Shackleton's historic ship "Quest." A group including surveyors, airmen and meteorologists sailed on July 3 for the Faroe Islands, Iceland and Greenland, where they will stay an entire year exploring a route to the North American continent. The Canadian government has shown great interest in the proposal and will soon undertake a survey of the Canadian end of the proposed route from Winnipeg up through Hudson Bay and Baffinland.

The expedition, which is being sent under the auspices of the Royal Geographical Society, will be equipped for a thorough meteorological and geographical survey of Greenland. Airplanes, fast motorboats and dog-teams for scouting trips will all be at the disposal of the expedition on the shores of Iceland and Greenland and on the vast ice-cap of the interior.

As the route has been surveyed an experimental flight will be made over the entire route from England to Canada and back. Not only is it the shortest route, but it has the advantage that the longest stretch of sea flying necessary is only 300 miles. For more than four fifths of the way there are natural emergency landing grounds and a system of gasoline dumps will be carefully organized.

The whole center of Greenland is a vast ice plateau about 500 miles across on a line between Iceland and Baffinland, and rising to 8,000 feet above sea-level. This plateau has been crossed only twice anywhere near its center, and all crossings have been made in summer.

The expedition will establish a base camp on the southeastern coast of Greenland and a station on top of the ice-cap. Meteorologists will stay on the ice-cap a whole year.

From this central base dog-sled expeditions will set out on journeys into the far north of Greenland and down to the south coast. The coastal base camp will be near the Eskimo settlement of Angmagsalik, about forty miles inshore. The central base will be about 150 miles inland on the highest part of the great frozen plateau.

The Prince of Wales has consented to be honorary president of the committee in charge. The leader of the expedition will be H. George Watkins, who led two previous Arctic expeditions. His companions will be Augustine Courtauld, explorer and surveyor; James M. Scott, surveyor and dog-driver; Flight Lieutenant N. Hughes d'Aets, pilot and meteorologist; Captain Percy Lemon, wireless operator; Lawrence R. Wager, geologist; Andrew Stephenson, chief surveyor; John Rymill, surveyor; Fred S. Chapman, ornithologist and ski expert; Quintin Riley, meteor-

ologist; Wilfred E. Hampton, engineer, and Lieutenant Martin Lindsay, surveyor.

The whole project has the warmest assistance of the British and Canadian government departments. The British Air Ministry has lent Lieutenant d'Aets, who is a Royal Air Force officer, while the War Office has lent Captain Lemon, one of its most expert wireless operators. Many government departments are helping with loans of instruments, while the Vickers Aviation Company has offered a Vellore plane for experimental flights and the Royal Geographical Society has helped technically and financially.

A PRIMARY STANDARD OF LIGHT

THE Bureau of Standards has issued the following statement in regard to its work on a primary standard of light: Up to the present time no satisfactory standard has been available. In this country the unit of light (the candle) has been maintained by a group of 45 carbon-filament electric lamps, to which have been assigned definite ratings when burned under specified conditions. To keep the size of the unit of candlepower unchanged with such electric-lamp standards it was necessary that no changes take place in the lamps themselves, a requirement which can not be met indefinitely by any electric lamp or group of lamps.

The new light source consists of a hollow inclosure of fused thoria immersed in a bath of pure freezing platinum. It is reproducible in that it can be set up anew at any time and does not depend upon the unchanging character of any particular pieces of material. It depends only upon the constancy of a natural phenomenon, namely, the fact that pure platinum will always freeze at the same temperature. The light emitted each time the source has been set up anew has been found to be the same, as compared with the bureau's carbon electric lamp standards, within 1 part in 1,000. This is about the limit of accuracy attainable in photometry.

The old electric lamp standards were irreplaceable and their loss or a serious change in their properties, such as must eventually occur, would in the past have been nothing less than a catastrophe. If, however, such a loss occurred now, the bureau could replace these lamps without the assistance of outside laboratories by rating a new set of lamps in terms of the light emitted by the platinum standard. The relation of this light to the present unit of candlepower has been accurately established as one candle for each 1,700 square millimeters of opening.

It happens, fortunately, that the color of the light emitted by the new standard is practically identical with that emitted by the old standard. It is hoped that before very long the new light source will be recognized generally and adopted as an international standard.

REFORESTATION DURING 1929

FOREST planting by all the principal agencies engaged in the work of reforestation in the United States last year restored to tree growth a total of 111,175 acres, as shown by records just completed by the Forest Service.

The total acreage set out in young forest trees in 1929 included 107,557 acres in the continental United States, 2,084 acres in Hawaii and 1,534 acres in Porto Rico. Reforestation activities included the planting of 31,430 acres by 21 states and two territories, 5,920 acres by municipalities, 25,088 acres by industrial organizations, 539 acres by schools and colleges, and 1,516 acres by other organizations. Plantings by farmers for the extension or improvement of farm woodlots and windbreaks amounted to 24,825 acres, and plantings by other individuals, 6,650 acres. The U. S. Forest Service planted 18,027 acres of land on national forests in 1929.

Michigan, with 27,820 acres restored to tree growth, led the states last year in total acreage planted to forests. New York ranked second with 21,135, and Louisiana third with 10,583 acres. Other states which ranked high in forest-planting activities were Pennsylvania with 6,318 acres; Washington, 4,400 acres; Massachusetts, 3,938 acres; Ohio, 3,428 acres, and California, 3,023 acres.

Industrial forest plantings in 1929 included 10,060 acres planted by pulp and paper companies, 8,732 acres by lumber companies, 3,189 acres by water and power companies, 1,561 acres by mining companies, 100 acres by railroad companies and 1,446 acres by other industrial organizations.

To the end of the calendar year 1929, the cumulative total of all forest planting in the United States of which the Forest Service has record was 1,653,308 acres. This included 274,385 acres of national forest land planted by the federal government, 200,553 acres by states, 46,282 acres by municipalities, 193,262 acres by industrial organizations, 16,335 acres by other organizations, 5,215 by schools and colleges and 917,276 acres by farmers and other individuals. In cumulative acreage planted, Iowa led with 242,260 acres, Nebraska was second with 219,088 acres, Kansas third with 201,190 acres and New York fourth with 183,369 acres.

YALE UNIVERSITY AND THE BERNICE P. BISHOP MUSEUM

YALE UNIVERSITY and the Bishop Museum, Honolulu, have entered into a new agreement which will bring about a closer affiliation of the two institutions.

The research program of the museum, the only institution which devotes its energies solely to a study of the Pacific area, will be integrated with the activities of those departments of the Yale Graduate School

whose work bears on the scientific problems of the Pacific. This is expected to improve the work of the museum by bringing it under the supervision of the scientific men at Yale, and will strengthen the educational program of the Graduate School by making available for purposes of instruction and research materials obtained by the museum through its field study of Pacific problems.

To give effect to this purpose it has been agreed that the director of the museum shall be a member of the faculty of the Graduate School assigned to duty in Hawaii. The present director is Professor Herbert E. Gregory. Each year the museum will send to Yale a visiting professor to give instruction and direct research in the problems of the Pacific area. A standing committee of the Graduate School will undertake to supervise the research program of the museum, to correlate this with the activities of the scientific departments at Yale, and to plan and direct the work of the visiting professor. To stimulate among graduate students interest in the problems of the Pacific, fellowships of large stipend will be awarded annually to students who are qualified to engage in research under the direction of the museum.

President Angell points out that "the research activities of the Bishop Museum in the natural and social sciences have been of the highest scientific value. By reason of its central position it is strategically placed to study the cultural, geological and zoological problems of the Pacific area. This it does through scientific expeditions to the islands and bordering mainlands which gather data of great importance to the anthropologist, the social scientist and the scholars interested in different branches of the natural sciences. Hereafter these activities will be a part of the general program of the Yale Graduate School."

The Bernice P. Bishop Museum has given much attention to the native races of the Pacific. The studies entered upon by Yale and the museum have led to the discovery of ruins of great antiquity in the Mariana islands, between Hawaii and the Philippines, which indicate a vanished civilization in the Pacific comparable to that of the ancient mainland. These ruins are expected to throw light on the origin and immigration of the Pacific people. By some routes in the distant past these people left the Asiatic continent and spread over an area 8,000 miles long and 6,000 miles wide. To trace these routes and to find out who these early people were is one of the problems which the investigators at Yale and the museum are trying to solve. It was in investigating a probable route from Mongolia through Japan to the Marianas and thence to Samoa and Hawaii that these significant ruins were discovered.

FURTHER ACADEMIC DISMISSALS IN MISSISSIPPI

THERE were recorded in the issue of SCIENCE for July 18 the professors dismissed from the University of Mississippi.

On July 5, 1930, the Board of Trustees of the University and Colleges of Mississippi, without warning, giving of reasons, or preferring charges of any sort, dismissed the members of the faculty of the Mississippi College of Agriculture and the Mechanic Arts, as listed below. It is said that the board plans to take similar action at the Experiment Station.

Charles F. Briscoe, professor of bacteriology.
F. J. Weddell, professor of English.
F. D. Mellen, professor of public discourse.
H. W. Moody, dean of the School of Engineering and professor of physics.
M. L. Freeman, professor of drawing.
J. C. C. Price, professor of horticulture.
Hal Fox, professor of mathematics.
J. R. Gulledge, librarian.
F. H. Herzer, associate professor of dairying.
A. G. Burg, associate professor of agronomy.
G. F. Barnes, associate professor of physics.
C. B. Cain, associate professor of veterinary medicine.
R. G. Dauber, assistant professor of physical education.
L. S. Lundy, assistant professor of mathematics.
G. B. Drummond, assistant professor of mathematics.
J. R. Ricks, director of experiment stations.
R. S. Wilson, director of extension.
J. W. Willis, assistant director of extension.

The president, B. M. Walker, and the vice-president, J. C. Herbert, had been displaced at an earlier meeting. Many secretaries, stenographers and others were among those dismissed.

SCIENTIFIC NOTES AND NEWS

DR. STEPHEN MOULTON BABCOCK, emeritus professor of agriculture and chemistry at the University of Wisconsin, the inventor in 1890 of the Babcock milk test which revolutionized the dairy industry, is to receive the Capper award of $5,000 and a gold medal at the annual meeting of the American Country Life Association, to be held at the University of Wisconsin from October 7 to 10.

THE University of Freiburg has conferred the honorary degree of doctor of natural philosophy upon Dr. F. W. Aston, of Cambridge, in recognition of his work on isotopes and other subjects.

THE honorary degree of Sc.D. was conferred on July 4 by the University of Dublin on Sir John Hopwood Jeans, secretary of the Royal Society.

IT is stated in *Nature* that in connection with the International Botanical Congress, which is to be held in Cambridge in August, it has been decided to confer honorary degrees on the following: John-Isaac Briquet, director of the Conservatory and Botanic Garden, Geneva; Pierre Augustin Clément Dangeard, professor of botany at the Sorbonne; Friedrich Ludwig Emil Diels, professor at the University of Berlin and director-general of the Botanic Garden and Museum at Berlin-Dahlem; Thore Gustaf Halle, professor and keeper of the Paleobotanical Department of the Swedish State Museum of Natural History, Stockholm; Lewis Ralph Jones, professor of plant pathology at the University of Wisconsin; Carl Joseph Schröter, emeritus professor of botany at the Technical University of Zurich, and Friedrich August Ferdinand Christian Went, professor of botany and director of the Botanic Garden and Laboratory of the University of Utrecht.

DR. LUDWIG A. THIELE, chemical engineer, Gowanda, N. Y., was recently awarded the degree of doctor of science by the University of Brussels.

THE Louisiana State Medical Society gave a dinner in New Orleans on July 12, in honor of Senator Joseph E. Ransdell, author of the bill to establish a National Institute of Health. The speakers were Dr. Joseph C. Bloodgood, of the Johns Hopkins University; Surgeon General Hugh S. Cumming, Washington, D. C.; Dr. Edward Starr Judd, of the Mayo Clinic; Dr. Charles H. Herty, of the Chemical Foundation, New York, and Dr. Rudolph Matas, of the School of Medicine of Tulane University.

THE new department of medical and surgical research, instituted in the Ohio State University College of Medicine, Columbus, will soon begin work. Dr. Charles A. Doan, the director, has recently arrived from the Rockefeller Institute, New York. Dr. Bruce K. Wiseman will be the assistant director. The department will be inaugurated in Hamilton Hall, where it will have access to the University Hospital.

DR. WILLIAM THORNTON READ, formerly head of the department of chemistry at the Texas Technological College, has been appointed dean of the newly organized School of Chemistry at Rutgers University. *Industrial and Engineering Chemistry* states that his work at Rutgers will include not only the training of Rutgers students of chemistry, but also the organizing of an extension program of instruction for chemists, ranging from the humblest plant man to the highly trained technical graduate.

J. E. MILLS, immediate past chairman of the division of chemistry and chemical technology of the National Research Council, formerly chief chemist of the Chemical Warfare Service, has accepted appointment as professor of chemistry in the University of South Carolina.

DR. LOUIS N. KATZ, who recently resigned his position as assistant professor of physiology in the School of Medicine of Western Reserve University, has accepted the post of physiologist and director of cardiovascular research at the Michael Reese Hospital, Chicago, and has been appointed assistant professor of physiology at the University of Chicago.

DR. H. M. LAKE is leaving the University of Texas to become instructor in psychology at Colgate University, where he will teach applied psychology.

ACCORDING to *Nature* new professors have been appointed at the University of London to chairs as follows: *Bacteriology* (University College Hospital Medical School), Mr. C. Cyril Okell; *Chemistry* (University College), Professor C. K. Ingold, now professor of organic chemistry in the University of Leeds; *Geography* (Birkbeck College), Miss E. G. R. Taylor; *Physics* (Imperial College—Royal College of Science), Professor G. P. Thomson, now professor of natural philosophy in the University of Aberdeen.

DR. LEE DE FOREST, director of the Institute of Radio Engineers, is preparing to move his entire organization to Hollywood, where he will engage in intensive work on apparatus used in motion pictures, television and ultra short-wave radio.

VICTOR T. STRINGFIELD and Charles V. Theis have been appointed assistant geologists in the Water Resources Branch of the U. S. Geological Survey.

DR. FRANCIS CARTER WOOD, director of the Crocker Cancer Research Institute of Columbia University, sailed on July 23 to attend the International Congress of Experimental Cytology at Amsterdam.

DR. D. T. MACDOUGAL, of the Carnegie Institution of Washington, has been appointed as representative of the Torrey Botanical Club to the International Conference on Plant Nomenclature.

THE New York Botanical Garden will be represented in the fifth International Botanical Congress at Cambridge, England, by Director E. D. Merrill, Dr. J. H. Barnhart, Dr. B. O. Dodge, Dr. H. A. Gleason and Dr. A. B. Stout. Messrs. Dodge, Gleason, Stout and Merrill have already left for England and Dr. Barnhart will leave early in August. They will remain in Europe until late in the fall as they are planning research work at Kew and other European institutions. Dr. Elmer D. Merrill is one

of the vice-presidents of the congress and also a vice-president of the section on taxonomy.

DR. M. O. MALTE, chief botanist of the national herbarium of the National Museum Branch of the Dominion Department of Mines, Ottawa, sailed from Montreal on July 29, to attend the International Botanical Congress. Before and after the congress Dr. Malte expected to visit the British Museum and the Kew Botanical Gardens to study collections of Arctic flora. He will also visit the Botanical Museum at Copenhagen for the same purpose.

DR. JESSE MORE GREENMAN sailed for Europe on July 30, as the delegate of the Missouri Botanical Garden to the Botanical Congress. Afterwards he will visit the great botanical centers of London, Brussels, Paris, Berlin, Vienna, Munich and Geneva for the study of types of American plants in European herbaria.

GUSTAVUS J. ESSELEN has been appointed by the National Research Council as the representative of the division of chemistry and chemical technology to attend the tenth Congress of Industrial Chemistry to be held at Liége, from September 7 to 13.

PROFESSOR CARL R. MOORE, of the department of zoology at the University of Chicago, and Professors R. G. Gustavson, F. C. Koch and Mr. T. F. Gallagher, of the department of physiological chemistry, are attending the second International Congress for Sex Research in London, which will be held from August 3 to 9.

DR. JOSEPH F. ROCK, working under the auspices of Harvard University and the U. S. Department of Agriculture, arrived at Hongkong on July 22, *en route* to the city of Lichiang where he plans to work for five years among the Nashi tribe. Dr. Rock also plans to conduct a study of medical and economic plants of the region for introduction into the United States under the supervision of the Department of Agriculture.

HAVING completed two months' lecturing and studying at the Institute of Biology at Tohoku Imperial University, Sendai, Professor Charles A. Kofoid, of the University of California, will spend the rest of his time in Japan at the institute's marine station at Asamushi, giving graduate instruction and carrying on research. In August he will read a paper before the Japanese Zoological Society on "The Neuromotor System of a Protozoa."

THE one hundred and sixty-fifth anniversary of the founding of the University of Pennsylvania's School of Medicine, the oldest on the American continent, will be celebrated on October 10 and 11. There will be a university convocation, at which honorary degrees will be conferred upon a number of men who are internationally known in the field of medicine. Included among these will be Sir Walter Fletcher, of London, executive secretary of the Research Council of Great Britain, and Professor A. V. Hill, of the institute of physiology, University College, London. Sir Walter and Professor Hill will deliver addresses during the celebration. In the afternoon there will be a series of meetings and clinics. On the following day the tentative program calls for an inspection of new buildings in the medical group. Among the recent developments to which attention will be called are the erection of the Martin Maloney Memorial Medical Clinic Building, the establishment of the Eldridge R. Johnson Foundation for Research in Medical Physics, the Edward B. Robinette Foundation for the study, treatment and prevention of diseases of the heart and circulatory system, and the reestablishment of the Pepper Laboratory for Clinical Medicine and of the John H. Musser Department of Research Medicine in the new Maloney Clinic Building.

THE formal opening took place on June 30 of the new animal breeding research department of Edinburgh University. An address, in which he made a defense of vivisection, was given by Professor Sir Edward Sharpey-Schafer. Occasion was also taken to confer the honorary degree of LL.D. upon Mr. T. B. Macaulay, president of the Sun Life Assurance Company of Canada, who some time ago endowed a lectureship in the department for the encouragement of research directed towards human physiological problems.

THE degree of bachelor of science has been abolished by the board of trustees of Princeton University. Beginning with the class of 1934 all graduates, except those in the engineering school, will receive the bachelor of arts degree.

MR. CYRUS H. K. CURTIS, of Philadelphia, has given $500,000 to Bowdoin College and $100,000 to the Maine General Hospital at Portland.

AT the recent session of the board of regents of the University of Texas, plans and specifications were authorized for the enlargement of the present laboratory building of the state medical college. The cost will be approximately $350,000.

MR. EDWARD S. HARKNESS, of New York, is reported to have offered £2,000,000 to endow social and educational work in Great Britain.

APPROPRIATIONS amounting to $410,008 were made available to the University of Wisconsin by recent action of the emergency state board, releasing funds

to that amount to the board of university regents. The largest single item is $169,508 for the construction and equipment of an agronomy wing to the horticultural building. The next largest is $100,000 for the construction of an addition to the present student infirmary. Other items include $27,500 for the purchase and installation of safety devices throughout a number of university buildings; $22,000 for moving equipment from its present location to the new mechanical engineering building in process of erection at Camp Randall; $25,000 for an electric distribution system; $15,000 for a water line to the pump house; $16,000 for the purchase of real estate, and $35,000 for the construction and equipment of a new building for animal research.

ACCORDING to the terms of a recent appropriation by Congress, the United States Department of Agriculture will establish a new field laboratory on the Pacific coast to study problems of bee-keeping in that region. The site of the new laboratory has not been selected, but a location in which most of the problems to be studied will apply is being sought. In addition to the bee-culture laboratory near Washington, D. C., the department now operates field laboratories at Laramie, Wyo., and Baton Rouge, La. The bill provides $15,000 for bee-culture investigations on the Pacific coast with the new field laboratory as headquarters.

APPROXIMATELY 14,144 acres of land were added to the Rocky Mountain National Park, Colorado, by proclamation of President Hoover dated June 25, upon recommendation of the Secretaries of the Interior and Agriculture. Authority for the addition of the land was contained in the act of Congress approved on June 21. The new addition adds to the park the headwaters of the Colorado in the vicinity of the Never Summer Mountains, picturesquely so-called by the Indians because of the everlasting snows that spatter their summits. This is a magnificently scenic area. In this region the Continental Divide makes a U-shaped loop, forming a broad valley through which the Colorado River winds. About one third of this basin was included in the national park, the remaining portion being in the adjoining national forest. Under the presidential proclamation it is all included within the park. In addition to its scenic value, the new area is of geologic interest and constitutes a natural unit of the park. Through it will be constructed a portion of the new Trail Ridge road, which, when completed, will be the highest continuous road in North America. At one point it will reach an altitude of 12,120 feet, and 9 miles of its total length of 28 miles will be located above timberline.

THE French Minister of Public Instruction has, according to the *Journal* of the American Medical Association, appointed a commission to draw up a bill to provide that, out of the profits of commercial establishments exploiting a scientific discovery, a certain proportion shall go to the benefit of the scientists who made the discovery. Such a law has been demanded for many years, and the Commission Internationale de Coopération Intellectuelle has already discussed the subject at length. It has conceded, in principle, that it is just to recognize the existence of certain rights of ownership in scientific inventions and discoveries, just as the rights of ownership in artistic productions are recognized. A French law, which dates back three years, accords to the author of a painting and to his descendants for a period of fifty years after his death a *droit de suite,* that is to say, a percentage of the price paid for the picture every time it is resold. It has been considered unjust that a work of art for which the artist who creates it usually receives a low price should enrich several merchants by successive sales and speculations whereas the artist and his family remain in misery. It is now regarded as no more than just to apply the same principle to the author of a scientific discovery which, even though it can not be patented, will, by exploitation, enrich a number of industrialists and merchants. Laboratory workers receive modest salaries in the faculties or the scientific institutes, but their research becomes for others a source of wealth in which they have no part. A small percentage will therefore be figured on the profits of industrialists exploiting a discovery that is not entitled to a regular patent, and the sums thus collected will be placed in a special fund destined to furnish indemnification to the scientists who are the authors of exploited discoveries. This fund will be a *caisse commune,* which can be used likewise to indemnify other scientists, authors of discoveries in pure science and not capable of exploitation. The fund may be used also for the creation of research laboratories and experimental hospitals. A special commission composed of scientific men acting under the ministry of public instruction and administer the fund and will see to its judicious distribution.

DISCUSSION

CONIFER INFLORESCENCE

STROBILAR structure and origin form a much more enigmatic subject than can be readily pictured. At once an utter difficulty of definition and the tangle of inequal terms is encountered. The relation between the cone and flower is tied up with the inflorescence. Inadvertently the student thinks that a flower has no semblance to the unit of structure in a cone

and that the cones of pines must be far simpler and older than any flowers, both ideas being the exact reverse of the truth. Giantism, reduction and elimination, even more than progressive changes, obscure the primitive structures, while the view that the higher seed plants arose somewhere near their first observed occurrence in geologic time has so dominated botanical thought that views of descent have been much too restricted to reach fuller clarity.

Within the past few years, however, much real progress has been made in the study of the ancient history of the conifers. Both Araucaria and the pines are traced back to the Carboniferous. Older cones are more complex and leafy; single scales fewer, and groups of seed scales suggesting shoots more in evidence. No less, unity in the entire Conifer-Araucaria phylum as it appears in the flora of to-day is very certain. In the fossil genus Pararaucaria accompanying the Araucaria cone series from the Cerro Cuadrado, Patagonia, bract and scale are both prominent, while the seeds are curtained by the tissues of the scale. Outer appearance was not markedly different from Picea or Larix, except in the much larger bract, although, as if nature intended to prove the point further from the fossil side, the scale, as normally one-seeded as in Araucaria, is rarely seen to be both one and two seeded in one and the same cone.

The shoot or inflorescence theory of the cone advanced at various times best seems to fit the increasing evidence. It is recalled that abnormal cones of Picea with leafy axes in the bract axils seemed to indicate the seed scale to be the remnant of a shoot. The apposed view was that the staminate and ovulate cones are strictly homologous, with the bract itself a sporophyll and the scale really an outgrowth from it bearing the seeds. But this latter view seems to fail, or at least can only suggest plants very much simpler than any conifers and living far back in time, plants embryologically simple as in early Cordaites or in pro Conifers. Much depends on the interpretation of the Gnetaleans. Did they all once have complete flowers? At least the flowering gymnosperms were a reality and can only be thought of as numerous and varied in Permo-Carboniferous and later times. Leaving embryogeny somewhat aside or as a thing in itself progressive, conifers might be as much the descendants of angiosperms as the reverse. That is, conifers are now specialized utterly in flower and foliage, though ancient in wood structure. Conversely, the angiosperms are still plastic in their flowers, but absolutely advanced in embryogeny, leaf and wood. Casuarina is an angiosperm which wanted to be a conifer, but started too late.

It is expected shortly to illustrate some of these points at length and adequately in an account of the Field Museum collections from the Cerro Cuadrado. In searching for collateral illustration use has been made of a hasty method of cone sectioning and illustration which may have escaped note by many teachers of botany. The great pine cones when thoroughly dry may with care be close wrapped in several ways to prevent breaking of the scales, and then set in the heavy oak jaws of an old-fashioned carpenter's vise and sawn through on the lines needed for all the desirable sections. A narrow, fine-toothed orchardist's pruning saw is about the best for the purpose. After sawing out the various sections it is, however, quite necessary to have at hand polishing laps of the lesser sizes run at rather low rates of speed to avoid breaking the projecting scales. Then instead of the felts used in ordinary petrified wood polishing, sand paper of several grades of fineness may be used to bring the surfaces of the sections down to the needed smoothness cleared of saw cuts. The sections need no staining and no treatment. The natural colors leave all features of the woody cylinder and bundle patterns in bold outline. The color values lend themselves to photography. By first loosing and setting aside the seeds these may then be replaced in the finished transverse section. The great cones of Coulter's pine, the Sabine pine and the knobcone and sugar pine so sectioned afford remarkable material for classroom use in botany. No one who has seen such sections will ever again be in doubt about the organization of the cone, the features of the woody cylinder, the origin of the bract and scale supply and their features as they traverse the cortical parenchyma to divide up for the later course in bract and scale. Even the smaller cones can be similarly seen. The impression gained will be one of a remarkable unity in the general features of seed cones throughout the conifers, just as emphasized by Eames, studying Agathis several years ago, and by Worsdell.

Of course the student ought to hold in mind a variation of type which runs all the way from such an open lax cone as that of *Podocarpus andinus* to the giant close-set woody types, or yet includes cones, inflorescences, reduced to but a single seed as in the yew, where the modified seed scale is quite surrounded by bracts. He ought to recall that the angiosperms are a unit in which the flower was present in very ancient days, and that the ament of the poplar and the willow results from inequal reduction of those primitive flowers to forms analogous to coniferous fertile shoots. He ought to see that the cycadeous strobilus is the remote prototype of the magnolia seed cone; that there must be hidden in the older rocks

an amphisporangiate strobilus, either simple or complex. That strobilus is in a measure visualized in Cycadeoidea. Maybe it is seen in Tumboa. In any case it was a forerunner of flower and cone.

G. R. WIELAND

YALE UNIVERSITY

THE SPECTRA OF GASES LIGHTED WITH STRONG ELECTRICAL DISCHARGES

THE spectrum of a gas is known to vary with the pressure and the type of electrical excitation. Experiments were undertaken to find out what the spectrum of the gas is like when very strong discharges are used. A small discharge tube containing the gas at pressures up to several cms of mercury was arranged to be excited either in the usual way by the discharge of a transformer, or by a small 0.002 microfarad condenser, or by the violent discharges of a 1 microfarad condenser charged to 15,000 volts. The discharge of a 1 microfarad condenser at this voltage is quite an energetic affair; it produces a blinding flash of light and a pulse of sound like a gunshot. With hydrogen in the tube the Balmer lines widened with increasing strength of the discharge, the higher members of the series disappeared and the continuous spectrum became more intense, until with the 1 microfarad condenser discharges there were no Balmer lines left at all, only the continuous spectrum and some absorption lines due to aluminum from the electrodes, etc. Helium, oxygen and nitrogen exhibited similar changes, *i.e.*, with increasing intensity of the discharge in helium the lines gave way to a continuous spectrum, and in oxygen and nitrogen the molecular bands gave way to spark lines and these in turn to a continuous spectrum. The continuous spectra from all the gases were closely alike. The intensity distribution across the continuous spectrum was rather even and probably not that of a black body.

The result of the experiments was in some respects a surprise, although to be sure as the experiments progressed one could see in what direction they were headed. That certain lines would widen or disappear in the intense discharges was to be expected, but to find all the lines wiped out and their places taken by a smooth continuous spectrum was hardly anticipated. It seems that the external characteristics of the atoms were pretty well effaced. One may imagine that the conditions approached those in the interior of a star.

E. O. HULBURT

NAVAL RESEARCH LABORATORY

SCIENTIFIC MINUTE MEN IN ANTHROPOLOGY AND ARCHEOLOGY

IN cooperation with the Division of Anthropology and Psychology of the National Research Council, Science Service has arranged a plan by which competent and accurate reports of rumored discoveries relating to anthropology and archeology may be obtained for prompt publication in the press. The committee, appointed by the Division of Anthropology and Psychology, National Research Council, is as follows: Dr. Roland B. Dixon, Harvard University, Cambridge, Massachusetts; Dr. A. L. Kroeber, University of California, Berkeley, California; Dr. Leslie Spier, University of Washington, Seattle, Washington, and Mr. Neil M. Judd, chairman of the committee, U. S. National Museum, Washington, D. C. Dr. Fay-Cooper Cole, chairman of the division, has been helpful in formulating the plan.

The plan, briefly, is this. Selected anthropologists, geologists and paleontologists situated in geographically strategic localities are commissioned special correspondents of Science Service and authorized to visit and investigate any reported discoveries in their vicinity which may appear important or likely to receive wide publicity. Science Service guarantees to defray expenses up to $50.00; more than this, by prior agreement. Specific authorization is not required but the collaborator uses judgment in determining what needs investigation and, to avoid duplication of effort, first ascertains that others near by are not also starting out on the same report.

Before starting on any specific investigation, each investigator states what is known of the reported discovery, his personal plans, telegraphic address, etc., in a concise telegram sent press rate collect to Science Service, Washington, D. C. He does not wait for an answer but proceeds immediately with the investigation. Upon arrival at the site, the results of preliminary investigation are telegraphed to Science Service. Details and photographs are sent as soon as possible by mail.

Investigations are restricted to reported discoveries that seem likely to be of real importance or that seem likely to create considerable publicity. Science Service, supplying science news to a fifth of the newspaper reading public in America, is desirous through this plan to distribute accurate and prompt news of all important archeological and anthropological investigations before exaggerated and misleading statements are circulated.

The investigator arranges with his institution to coordinate his efforts under this cooperative plan with his activities on behalf of his institution. The scientific results of any investigation may be published as the scientist sees fit, but news reports and public statements, in consideration of the participation of Science Service, are distributed exclusively through Science Service.

Sixty-six archeologists and anthropologists located

in strategic centers in the United States and Canada are now designated as Science Service minute men in archeology and anthropology under this plan.

Two investigations under the plan have already been made. Drs. Alfred S. Romer and Wilton M. Krogman, of the University of Chicago, and Russel T. Neville, of Kewaunee, Illinois, visited a cave in Leasburg, Missouri, where human remains were reported to be found and they determined that the bones were those of bears. When a report of the discovery of "prehistoric giants in West Virginia" gained wide currency, D. T. Stewart, of the U. S. National Museum, visited the site of the bone discoveries near Morgansville, West Virginia, and found that the bones were probably those of normal-sized Indians. In cooperation with Professor Ernest R. Sutton, of Salem College, he excavated further in the mounds and inspired local amateur archeologists to more effective research in a territory which is largely an archeological no-man's-land.

In addition to the news reports of the investigations which will find publication in newspapers and magazines through the usual channels of Science Service, more detailed announcements of these researches will be prepared and sent upon request to those who express an interest.

WATSON DAVIS

SCIENCE SERVICE

TWO UNUSUAL FLOCKS OF SWANS

IN recent years the appearance of the whistling swan, *Cygnus columbianus* (Ord), in large numbers is so unusual an event that the occurrence of a flock of fifty is a matter of note among ornithologists. Forbush,[1] in reference to this bird states, "In New England we rarely see or hear them now. Once they were abundant in migration along our coasts and many a lake. . . . Now the few that pass over or through our territory fly so high that they are rarely noticed, or they keep well out on wide water during daylight." Barrows, in his "Michigan Bird Life," says, "Single birds or small squads occasionally alight during bad weather in ponds and streams in various parts of the state," and quoting Butler,[2] "'Formerly when these birds were more abundant they migrated in flocks of twenty or thirty, and sometimes as many as fifty high in the air.'" In Wisconsin, Schorger has just issued a report on the birds of Dane County. The territory covered by the report includes a number of lakes which are much frequented by waterfowl during the season of migration. The observations recorded extend over a period of twenty years, but swans were seen in only three of these, and on only seven different occasions. The largest flock observed contained forty individuals; the others less than eight each.

All the authorities cited lay special emphasis on the rarity of the bird. The appearance this spring of a large number of swans on Lake Winnebago seems therefore to merit notice.

About the first of April swans were reported to be at the northwest extremity of the lake, near Neenah. The writer visited the locality on April 5. The birds were shy and remained well off shore, but a count was possible through glasses. The number of individuals was ascertained to be two hundred.

On the same day a larger flock was reported from a location twelve miles south near Oshkosh. On April 7, after photographing the Neenah flock, which had apparently diminished little if at all in numbers, the writer drove to the Oshkosh shore. The flock here was stretched out in a great band approximately a mile in length and more or less paralleling the shore line. So close in was this band that the red beaks of the younger birds showed prominently and even the yellow spots on the beaks of older birds could be distinctly seen through six-power glasses. The individual birds were counted and found to number one thousand and seven.

A third flock, of small size, was reported to be at the southern end of the lake but this report has not, up to date, been verified. We have, however, knowledge of approximately twelve hundred swans on the lake at one time.

Accounts obtained from residents along the lake shores varied so widely that it was out of the question to determine just when and in what numbers the birds had arrived. But it is certain that these flocks are not remaining intact in their migratory movements. The smaller group in disappearing during the night of April 8 left three of its number on the lake. The larger flock shrank to one hundred and seventeen individuals between the eighth and noon on the tenth. All afternoon, on the latter date, swans in groups of from three to seven individuals left the feeding grounds until at evening only sixty remained. Three days later these sixty stragglers were still on the lake.

NELL A. ROGERS

APPLETON, WISCONSIN

[1] Edward Howe Forbush, "Birds of Massachusetts and Other New England States," p. 304.

[2] Amos W. Butler, "Notes on Indiana Birds," *Proc. Ind. Acad. Sci.*, 1891.

CURIOSITIES OF SCIENTIFIC NAMES

I AM very much interested in Dr. Howard's notes, page 330 of SCIENCE for October 4, entitled "Odd Stories about Scientific Names." Some enterprising scientist could compile a book full of such stories and

it would make good reading. Is it not an error to perpetuate errors in scientific names? Only yesterday my attention was called to the following: A deer was found in Big Pine Key in South Florida different from the common deer (*Odocoileus virginianus*). Barbour and Allen gave it the subspecific name *clavium,* meaning "of the Keys." Unless my Latin is very much at fault, this word refers to the kind of keys that you lock doors with, and is no way related to the word quay, cay or key—terms applied to little islands on the Florida coast and in the West Indies. The word "keyensis" or "cayensis" should be used.

There are many like the following.

Our Fiddle-wood belongs to the genus Citharexylon, which means fiddle or violin wood. The woods of this genus are usually extremely heavy and hard and probably have never been used in the manufacture of fiddles. The word fiddle in this instance is probably a corruption of the French word *fidèle,* meaning strong, true and trustworthy.

We should be all the more careful because errors in nomenclature seem to stick forever, as in the word Cocopalm. Many books still insist that coco comes from *kokkos,* the Greek for seed, and there is apparently no reason for it except the superficial similarity of the words. When L. named the genus Cocos he probably had the word coccus in his mind.

The serious business of naming persons and places is even more haphazard. A colored woman in Key West liked the name "Dora," but it was too common in her neighborhood. A naval officer for whom she worked suggested "Cuspidora" in a joke. The child was so christened and is probably the only person in all the world with such a name. No doubt many plant and animal scientific names have a similar basis.

JOHN C. GIFFORD

SPECIAL CORRESPONDENCE

THE ADVANCEMENT OF GEOLOGY THROUGH COOPERATIVE RESEARCH

BECAUSE it has become evident that the advancement of the geological sciences requires the cooperation of a number of highly trained specialists, a geological expedition is now being organized to make a comprehensive study of the exceedingly interesting region just north and east of Yellowstone National Park. According to the plans formulated federal and state agencies, universities, research organizations and individual scientists will cooperate in the threefold plan of training students, conducting scientific research and studying mineral deposits which may be found to have commercial value.

Work planned for the present summer includes airplane and topographic mapping by the War Department and U. S. Geological Survey, and geological field work by the Montana Bureau of Mines and Geology and the U. S. Geological Survey; and during 1931 gravity studies will be made in the region by the U. S. Coast and Geodetic Survey in an effort to compare and harmonize geological and geodetic evidence afforded by the area.

Preliminary studies of the geography, land forms and glacial geology of the Beartooth Plateau and adjacent lowlands will be made jointly by Professor Nevin M. Fenneman, of the University of Cincinnati and National Research Council; by Professor Paul McClintock, of Princeton and the Illinois State Geological Survey, and probably by Dr. Arthur Bevan, who was formerly at the University of Illinois, is now state geologist of Virginia and did his thesis work for the University of Chicago on the physiography of the Beartooth region.

Study of the Cambrian geology of the region, which is a continuation of the work of the late Dr. Charles D. Walcott, of the Smithsonian Institution, will be directed by an informal committee consisting of Dr. C. E. Resser, of the U. S. National Museum; Dr. Ira Edwards, of the Milwaukee Museum, and Professor B. F. Howell, of Princeton. Work on special details of local Cambrian geology is to be done by Gordon Knox Bell, Jr., of New York City, a graduate of Harvard and at present a graduate student at Columbia University.

Work on the chromite deposits and other ore deposits of the Beartooth region, and on the intrusive and volcanic rocks of the area, will be planned by a group including Dr. C. H. Clapp, president of the University of Montana; Dr. Francis A. Thomson, president of the Montana School of Mines and director of the Montana Bureau of Mines and Geology; Professor A. F. Buddington, and Professor Edward Sampson, of Princeton. Special phases of the petrologic work will be taken up by Dr. E. L. Perry, of Williams College.

The underground water resources of the Montana portion of the area will be studied by Dr. Eugene S. Perry, of the Montana Bureau of Mines and Geology, assisted by students from the Montana State School of Mines; and the coal and oil geology of the region will be studied in a broad way by Dr. C. E. Dobbin, of the U. S. Geological Survey; and by Dr. W. T. Thom, Jr., of Princeton, who is a participant in the research work of the American Petroleum Institute

and American Association of Petroleum Geologists, besides being a member of the National Committee engaged in the scientific classification of North American coals.

The study of the structure of the mountains and subsidiary folds of the region will be planned by a group including Dr. Thom; Professor Walter H. Bucher, of the University of Cincinnati; Professor Chester R. Longwell, of Yale, and Professor Rollin T. Chamberlin, of the University of Chicago.

The fossil plants associated with the volcanic deposits lying east of the Yellowstone Park, or included in the river-laid clays of the Big Horn Basin badlands, will be collected and studied by Dr. Erling Dorf, with the advice of Dr. R. W. Chaney, of the Carnegie Institution, and Dr. David White, of the U. S. Geological Survey. Dr. Dorf has been assisting Dr. Chaney for several years in the study of the Pliocene floras of the Pacific Coast sponsored by the Carnegie Institution of Washington, and the doctor's thesis recently submitted by Mr. Dorf to the University of Chicago covered a part of these paleobotanic studies and is being published by the Carnegie Institution.

Study of the processes of marine and continental sedimentation as illustrated by the sedimentary forms of the Big Horn Basin region will be developed by Professor R. M. Field, of Princeton, as a continuation of his studies of sedimentation now taking place in the Bahamas and Florida east coast areas. Dr. Field, together with the other members of the International Summer School of Geology and Natural Resources, will visit the Yellowstone and Big Horn Basin regions this summer. Foreign guests of this year's summer school include: Dr. Frank Debenham, head of the department of geography of Caius College, Cambridge University; Dr. H. Schneiderhöhn, professor of economic geology and director of the Mineralogical Institute of the University of Freiburg; Dr. P. Ramdohr, professor of mineralogy of the Mineralogical Institute of Aachen; Dr. Otakar Matousek, associate professor of methods of geology, Charles IV. University, Prague, Czechoslovakia.

Administrative direction of the field research work is under the direction of Dr. Thom, acting with the advice of Professor J. P. Rowe, chairman of the department of geology at the University of Montana, and of Professor Field as director of the International Summer School. Doctors Dorf and Perry will participate as executive assistants as well as scientific investigators.

A cabin colony will probably be established in 1931 at some strategic point along the eastern or northeastern foot of the Yellowstone Park Plateau. This colony will serve as headquarters both for the students who are receiving practical training and for the experienced geologists who may wish to spend their summers in group study and research in the Yellowstone-Big Horn Basin province.

Through the prosecution of plans laid out by such a group of scientists, it seems certain that geology will be advanced as a science and that a popular understanding of geology and an appreciation of the work of the federal and state surveys will both be promoted to an appreciable degree.

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SCIENTIFIC BOOKS

Mathematical and Physical Papers. SIR JOSEPH LARMOR. In two volumes. Vol. I, pp. xii + 679; Vol. II, pp. xxxii + 811. Cambridge University Press, 1929.

THESE two large beautifully printed volumes contain one hundred and four papers on mathematics and mathematical physics as well as nearly fifty additional notes or papers in the form of appendices, a few of which follow the papers to which they refer but most of which are collected at the end of each volume. Nine papers relating to physical relativity have been omitted from the collection, since the author felt that their significance has been vitiated by more recent developments of the subject. The following rough classification of the one hundred and four numbered papers gives an idea of the range of Professor Larmor's interest. In mathematics without direct physical applications there are nine papers of which six are predominantly in the field of geometry. Twelve papers fall in the domain of dynamics, several of them having to do with celestial mechanics or geophysics; the theory of elasticity claims three, and hydro and aerodynamics seven. Relating to thermodynamics, statistics and atomic theory there are eight papers. The largest categories, however, are electromagnetism, including the ether, and optics. Although it is not possible to distinguish sharply between these two, we may classify thirty-seven as belonging to the former and twenty-two to the latter. Then there are three obituaries or appreciations (Gibbs, Kelvin, John Michell), a paper on the periodicity in sun-spots, an address before the British Association in 1900 on the "Methods of Mathematical Physics" and the presiden-

tial address delivered before the London Mathematical Society in 1916.

Professor Larmor's most valuable contributions to science were made in the golden age of classical physics, and his papers abound in references to Faraday, Ampère, Helmholtz, Carnot, Clausius, Kelvin, Maxwell, Stokes, Kirchhoff, Boltzmann, Gibbs and Rayleigh. The last half of the nineteenth century and the early years of the present century was a period in which the ether held sway as the most controversial and devastating subject with which theoretical physics had to deal. For this reason the most interesting papers in this collection are those dealing with the properties of this suppositious medium. These papers appeared during the years from 1894 to 1897 under the title "A Dynamical Theory of the Electric and Luminiferous Medium." Part I outlined the broad underlying principles of the theory; Part II developed the theory of electrons, and Part III, relations with material media. Impressed by Kelvin's remarks, in connection with Stokes' suggested explanation of the aberration of light, that the motion of the ether outside of matter must be of an absolutely irrotational character, Larmor took for his dynamical model of the ether a medium with rotational elasticity such as that which had been proposed by MacCullagh in 1839 in the effort to give a rational basis to Fresnel's discoveries in optics. On this theory electric fields are explained as strains in the medium, magnetic fields as velocities. MacCullagh's ether, like Kelvin's quasi-labile ether, yields equations of motion identical in form with the electromagnetic equations. Therefore the proper dynamical application of either of these ether models must lead to the same results as Maxwell's equations. Larmor, however, introduced a new element in his hypothesis of 1895 that electricity exists in the form of discrete charges—electrons. In this series of monographs he deals not only with those phenomena—such as propagation of light in isotropic and anisotropic materials—which depend only on the macroscopic properties of the medium, but also with phenomena such as dispersion which involve its microscopic structure. Finally he does not ignore the optics of moving media.

Among other important contributions, that numbered fifty-one has perhaps proved of the greatest significance in connection with modern atomic theory. This paper, entitled "On the Theory of the Magnetic Influence on Spectra; and on the Radiation from Moving Ions," was published in December, 1897. It is the one in which Larmor's Theorem, familiar to every student of the theory of the Zeeman effect, is developed. This theorem is vital on account of its generality, for it enables us to assert that the dynamics of the electrons in an atom—no matter how complicated the structure may be—is the same relative to rotating axes in the presence of a magnetic field as relative to fixed axes in its absence, provided only that second order terms are negligible.

These collected papers of a great mathematical physicist of the age when classical physics was at the height of its power constitute an important addition to the library of every student of the subject, and should have a place on the shelves of every departmental library.

LEIGH PAGE

A Chemical Dictionary, containing the words generally used in chemistry, and many of the terms used in the related sciences of physics, astrophysics, mineralogy, pharmacy and biology, with their pronunciations, based on recent chemical literature. By INGO W. D. HACKH, Professor of Chemistry, College of Physicians and Surgeons, School of Dentistry of San Francisco, California. Pp. 790. P. Blakiston's Sons & Co. Inc. Philadelphia, 1929.

THAT an individual should have undertaken, apparently singlehanded, to produce a book containing thirty to fifty thousand concise definitions of chemical and other scientific terms, portraits and a brief statement about the work of a considerable number of chemists and a short discussion of many of the most fundamental principles of chemistry seems almost incredible. The result is a book which is sure to prove very useful to chemists and to physicists, biologists, physicians and many others who make use of the facts of chemistry. No similar book has been attempted for more than a century.

The following illustrations of the varied and detailed information found in the book will give some indication of its value:

A table of alchemical and chemical symbols in parallel columns; a list of a dozen substances used in drying gases with accurate statements of the efficiency of each; the structural formulas of camphor, morphine, brucine, cocaine, nicotine, strychnine and dozens of other natural and synthetic alkaloids; list of the minerals containing nickel; table giving the composition of ten kinds of milk; a half-column about vitamins; diagram of the radioactive disintegrations.

Professor Hackh has long been known as a chemist with fresh and original ideas of his own, not always in accord with orthodox chemistry. These ideas are worthy of consideration and study and they are not obtruded in such a manner as to interfere seriously with the usefulness of the book.

In the opinion of the writer "univalent" and "bivalent" are more common American usage than "monovalent" and "divalent." There are some differ-

ences of opinion about this, however. The latter terms are mixed Greek and Latin. It is, of course, impossible to avoid errors in fact and some errors in proof in such a voluminous work. Users of the book who discover such errors will confer a favor both to the author and to future users of the book if they will notify Professor Hackh of such mistakes.

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The Oedogoniaceae. By L. H. TIFFANY. 253 pp., 64 pl., 25.5 x 17 cm. Published by the author, Columbus, Ohio, 1930.

THE algal flora of North America has been most incompletely explored, the modern studies mostly resulting in more or less elaborate local floras rather than general works. Regarding marine algae the situation is being materially improved, especially on the west coast,[1] and a comprehensive monograph of North American diatoms has appeared, but the present work is different in character from almost anything else dealing with algae attempted in this country.

This monograph is expected to initiate a series of revisions of the groups of filamentous algae. The author is fortunate in dealing with a very distinct and highly specialized group, and has utilized the great diversity of form and stature presented to give concise and decisive keys to the many species. The great difficulty which a phycologist always meets in dealing with a large genus in its world-wide distribution, namely, the intergrading of a multitude of minor forms, seems to have been very effectively dealt with. Two of the genera, Bulbochaete (48 spp.) and Oedogonium (195 spp.), are large, with many varieties, but Oedocladium is small, three of its four species resting on the largely unpublished work of I. F. Lewis. Nearly ten pages are devoted to a description of cell structure and the reproductive organs, and these give essential aid in the interpretation of the morphological peculiarities of the family. The description of cell division and the reproductive processes is more complete and modern than is elsewhere available. With data probably unequaled the writer discusses the habitats and periodicity of the major genera over the north central states area he, in conjunction with E. N. Transeau, has studied closely. Maxima in May and June are reported, with a few species showing in a second generation an October maximum. The length of time required to reach a normal full maturity, rather than subsequent environmental conditions, seems most significant in determining the time of fruiting. The family Oedogoniaceae is retained in the group Stephanokontae of the Chlorophyceae following the suggestion of Blackman and Tansley. By far the greatest bulk of the book is necessarily devoted to the systematic treatment of the various species and varieties, with the usual synonymy, descriptive data and distribution well and fully presented, though it would seem that a convenient grouping of countries was not followed. The critical notes care for changes of interpretation and close comparisons, and almost all the plants described are illustrated, mostly original, by redrawing of the original figures, or figures from some other authoritative source. Some seven novelties are described, but the discoveries of the author have largely been previously reported. Since the volume has no geographical limits, it is sure to be the standard reference work on the family for many years, and for all countries.

WM. RANDOLPH TAYLOR

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MANIFOLD DESICCATING APPARATUS FOR DETERMINING THE DRY WEIGHT OF SMALL SAMPLES OF WOOL[1]

THE desiccating apparatus discussed in this paper has been successfully used for some time in determining the dry weight of small samples of wool in connection with making determinations of the density in fleeces, that is, the number of fibers in a given area. Methods for taking these samples have been previously discussed by Burns,[2] Hultz[3] and Nordby.[4] Burns and Hultz have also discussed the method of calculating the number of fibers in the samples taken.

In determining the density in wool, samples .25 square inch in area are usually taken in different parts of the fleece. Each sample is thoroughly cleansed and treated with a yolk solvent, such as ether, and then air-dried. A definite number of fibers is counted out of each sample and weighed. The balance of the sample is also weighed. The total number of fibers in the original sample is calculated by dividing the weight of the original sample (sum of two weights) by the weight of the fibers counted, and

[1] Approved for publication by the director of the Idaho Agricultural Experiment Station as Paper 67.

[2] R. H. Burns, "Some Phases of Wool Inheritance in F_1, Generation," *Proc. Am. Soc. An. Pro.*, 1924; "Wool Analysis Density Determination," *Wool Rec. and Textile World*, V. 30, No. 902, 1926.

[3] Fred S. Hultz, "Wool Studies with Rambouillet Sheep," Univ. Wyo. Agr. Exp. Sta. Bul. 154.

[4] Julius E. Nordby, "The Idaho Wool Caliper and Its Application in Making Density Determinations," Ida. Agr. Exp. Cir. No. 52.

multiplying this result by the number of fibers in the counted sample. It is obvious that the most uniform results are available by desiccating to dryness the wool samples and the bottles in which the samples are kept.

The most satisfactory method used in this laboratory for driving moisture from wool is by means of passing heated air through the sample. Inasmuch as the water present in wool has a vapor pressure less than that of water under normal conditions it is obviously essential to heat the wool above the boiling-point of water in order to drive the contained moisture off as vapor. Barritt and King[5] made use of this principle in making comparisons of the actual moisture content of wool, referred to as true regain, with the commercial regain in an apparatus described by Barker and Hedges[6] and illustrated by King.[7]

The warm air distributing unit (Fig. 1) used with

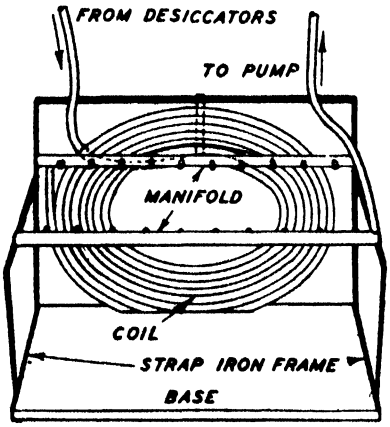

FIG. 1

this apparatus is adapted to a standard 18 x 12 x 14 inch, 220 V. electric oven. It is a removable unit composed of a steel frame into which are mounted a coil, made from twenty feet of one fourth inch copper tubing, and two brass manifolds each having ten three sixteenths inch jets. These manifolds are mounted in the steel frame in such a way that the bottles containing the wool samples (in this case U tubes with ground glass stoppers tightly fitted) may be attached to the jets by means of short pieces of a high-grade rubber tubing, which will maintain flexibility for two determinations. The air inlet and outlet of the unit pass through the ventilators in the oven top and extend above it sufficiently for outside connections.

The desiccators used are concentrated H_2SO_4, $CaCl_2$ and Mg $(ClO_4)_2$, all of which are provided in suitable containers for efficiently desiccating the air before it enters the heating unit. The air is drawn through the apparatus by means of a filter pump. Arrows in the accompanying figure indicate the direction of air movement. The desiccating efficiency of the H_2SO_4 has been enhanced by introducing the air through small perforations in bulbs blown into the glass tubing.

The temperature of the oven is raised to 105° C. before the filter pump is put into action. A two-way stopcock between the desiccating train and the oven makes it possible to run undesiccated air through the wool. This is done for fifteen to twenty minutes and is effective in removing the bulk of moisture from the wool samples, after which the air is passed through the desiccating train for approximately thirty minutes. The time required to reduce the samples to constant weight depends somewhat upon the rate of air movement through the apparatus which can be controlled by the filter pump and a stopcock between the filter pump and oven.

A mercury vacuum tube (Fig. 2) is part of the equipment and is very useful in operating the apparatus. It acts as an indicator of the air flow. The mercury trap stops any backflow of air into the wool samples. In the event the filter pump should suddenly stop there is a sufficient amount of mercury in the trap to satisfy the vacuum in the apparatus before the mercury supply in the trap is exhausted.

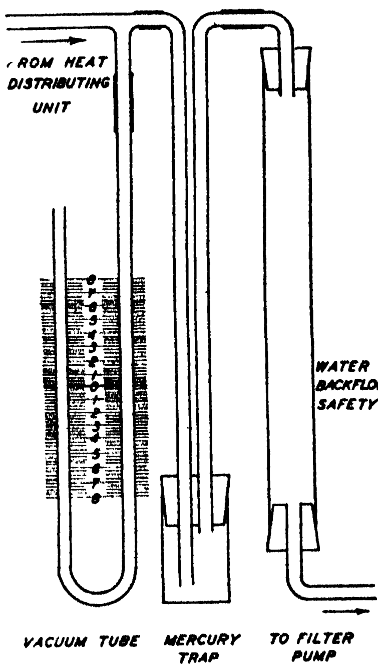

FIG. 2

[5] J. Barritt and A. T. King, *Jour. Text. Inst.*, 1926.

[6] S. G. Barker and J. J. Hedges, "Notes on the Determination of the Dry Weight of Wool." British Research Association for Woolen and Worsted Industries, Bul. No. 64.

[7] A. T. King, "The Determination of the Regain of Small Samples of Wool." British Research Association for Woolen and Worsted Industries, Vol. 1, No. 3, 1930.

An additional safety factor, in the form of a one inch glass tube, is installed to accommodate any back-flow of water between the mercury trap and filter pump.

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THE PREPARATION OF PERMANENT SLIDES OF THE RHIZOPOD ARCELLA

HEGNER[1] has recently described a convenient method for fixing and preserving specimens of the shelled rhizopod Arcella. By his method, Schaudinn's alcoholic-acetic-sublimate is poured over the animals while they are attached to the bottoms of Petri dishes, and clearing and preserving are effected by the use of glycerin.

We use a similar method in the preparation of slides of Arcella in our protozoology course, and it is believed that a note upon the method will be of interest, for it supplements Hegner's method in that it concerns the staining of the arcellas as well as their fixation. The procedure follows.

The arcellas, together with several drops of fluid, are transferred from a hay-infusion stock culture to clean micro slides. The slides are set aside in a moist chamber and are left undisturbed for at least half an hour. In this interval, many of the arcellas usually settle to the bottom of the fluid and attach to the slides by means of their pseudopodia.

The surplus fluid on a slide is now poured off. This operation leaves the animals still attached to the slide and covered only by a relatively thin film of fluid. Schaudinn's solution (used cold) is now dropped directly on the arcellas by means of a pipette and is left on the slide for two or three minutes. This method of fixation leaves the animals attached to the slide, frequently with pseudopodia extended. Thus the common difficulty of cementing protozoa to the slide is circumvented by the behavior of the arcellas themselves.

The slide is now ready for staining, and in this process it is treated entirely like a histological preparation. It is immersed in succession in the following fluids: 70 per cent. alcohol, made light brown by the addition of tincture of iodin (to remove sublimate), 30 minutes; 50, 25 per cent. alcohol, water, 1 to 3 minutes in each; dilute Delafield's hematoxylin (1 part stock Delafield to 3 parts water), 5 to 10 minutes; water, 25, 50, 70, 95 per cent. alcohol, absolute alcohol, equal parts absolute alcohol and xylol, pure xylol, 1 to 3 minutes in each; balsam.

If desired, Heidenhain's iron hematoxylin may be used instead of Delafield's. In this case, after fixation and treatment with iodin, the slides are hydrated, and are then mordanted an hour in 4 per cent. ammonio-ferric sulphate (iron alum). They are stained at least four hours in 0.5 per cent. aqueous hematoxylin solution and are destained in 2 per cent. iron alum, after which they are dehydrated, cleared and mounted.

In preparations stained by either method, the nuclei, of which there are two in most species, each with a conspicuous central karyosome, are revealed with diagrammatic clearness. The shell aperture and the extended pseudopodia are likewise well shown. Arcella is particularly favorable for the demonstration of chromidia, and by this method the chromidial bodies—commonly overlooked by students—are rendered clearly visible.

In conclusion, the method affords a convenient procedure for demonstrating certain cell organelles which are not readily observed in the living animal. Furthermore, the permanency of such preparations makes them available for class study or demonstration at times when living arcellas are not immediately obtainable.

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SPECIAL ARTICLES

ACTINO-URANIUM AND THE RATIO OF ACTINIUM TO URANIUM IN MINERALS

VARIOUS speculations have been advanced in the past about the origin of actinium.[1] However, the experimental evidence in all cases is fundamental. This evidence is (*a*) Boltwood's original work[2] on the "constancy" of actinium to uranium in several uranium-bearing minerals from North Carolina, all presumably of the same age; (*b*) the very important recent work of Aston on the relative intensities of the mass spectral lines Pb_{208}, Pb_{207}, Pb_{206} from the lead isotopes of a bröggerite from Karlhus, Raade, Norway,[3] and also Aston's similar work on the ordinary lead,[4] and (*c*) the observations of various investigators that the relation of actinium to uranium seems to vary somewhat in minerals which may be of different ages. Among these the most recent work is that of Wildish.[5]

Rutherford[6] using Aston's data and making certain

1 Robert Hegner, *Trans. Am. Micr. Soc.*, 48: 214, 1929.

1 Résumé in *Radioactivity Bull. N.R.C.*, No. 51, 1929.

2 B. B. Boltwood, *Am. J. Sci.* [4] 25: 269–298, 1908.

3 F. W. Aston, *Nature*, 123: 313, 1929.

4 F. W. Aston, *Nature*, 120: 224, 1927.

5 James E. Wildish, *J. Am. Chem. Soc.*, 52: 163–177, 1930.

6 Sir Ernest Rutherford, *Nature*, 123: 313, 1929.

assumptions deduced the half-value period of actino-uranium as $T = 4.2 \times 10^8$ years.

Piggot[7] expressed the opinion that if the relative intensities of the lead isotope lines 208, 207, 206 are known the age of the mineral can be accurately determined. He was instrumental in having the bröggerite lead and also the ordinary lead material prepared for Aston's analysis. On the basis of Aston's results on the bröggerite lead and their own chemical analysis of the mineral from which the lead was obtained, Fenner-Piggot[8] calculated the age of the mineral considering the 208, 207, 206 intensities as indicative of the relative amounts of Th D, Ac D and Ra G. They found, however, that the ages calculated on the basis of the uranium content and on the basis of the thorium content were in great disagreement. When one considers the probable error given by Aston for the intensities and also the small amount of thorium, one would expect some disagreement. However, any common lead present will introduce a very serious error in the calculations on the basis of the thorium content because the Pb_{208} line in the ordinary lead is one half of the total intensity, and if it is considered (in the calculations) as of Th D origin the age must come out greater than it should, and since the Th amount is relatively small, the error is proportionately greater.

In the work of the committee on the age of the earth of the National Research Council, I have frequently pointed out the error of neglecting the possible presence of common lead. I have developed formulas for the calculation of this amount and the age of the mineral basing the equations on the two fundamental facts, namely: I. The sum of the atoms of common lead (L), Ac D, Ra G, Th D equals the number of atoms in the lead isotopes found in the mineral; II. The sum of the masses of the common lead (L), Ac D, Ra G, Th D is equal to the total mass of the lead isotopes; and, of course, using the radioactivity equations of disintegration and of equilibrium. If the actinium series is considered as a branch from U II the equations obtained are

$$\frac{1.20\,U}{238.17}\cdot(e^{\lambda_u \cdot t}-1)-\frac{0.80\,Th}{232.15}\cdot(e^{\lambda_{th}\cdot t}-1) = Pb\cdot\left(\frac{207.20-A}{A}\right)$$

and

$$L = 207.20\left[\frac{Pb}{A}-\frac{U}{238.17}\cdot(e^{\lambda_u\cdot t}-1) - \frac{Th}{232.15}\cdot(e^{\lambda_{th}\cdot t}-1)\right]$$

[7] C. S. Piggot, *J. Wash. Acad. Sci.*, 18: 269–273, 1928.

[8] C. N. Fenner and C. Piggot, *Nature*, 123: 793–794, 1929.

in which U, Th, Pb and L are masses in grams of uranium, thorium and lead isotopes, and ordinary lead, respectively; and for the atomic weights: A refers to the lead isotopes and 206, 208 are used for Ra G (also Ac D) and Th D respectively. These equations presented at the Washington meeting of the American Physical Society in 1929[9] will be published in the report of the National Research Council committee and also in the *American Journal of Science.*

In this case L represents accurately the amount of common lead. If, however, the actinium descends from actino-uranium, an independent isotope of uranium, some Ac D is included in the value L and also a part of Ac D is included with Ra G. The part with Ra G depends on the actinium: uranium ratio, r. Then, if u ≡ number of atoms of uranium, r · u in final disintegration would be actinium lead atoms. The amount of Ac D thus considered with Ra G is

$$\frac{r\cdot U}{238.17}\cdot(e^{\lambda_u\cdot t}-1)\cdot 206.$$

This correction can be readily made when we are certain of this lineage and also of the value of the ratio, r.

Using Fenner-Piggot's analysis data, namely, $U = 61.158$, $Th = 4.377$ and $Pb = 8.018$, and Aston's $A = 206.19$, and assuming $r = 0.03$ and making the above corrections for Ac D we obtain for the age of this bröggerite $t = 825 \times 10^6$ years and for $L' = L + Ac\,D = 0.986$ gm per 100 gm mineral. Now,

$$Ra\,G = \frac{0.97\,U}{238.17}\cdot(e^{\lambda_u\cdot t}-1)\cdot 206 = 6.856$$

$$Th\,D = \frac{Th}{232.15}\cdot(e^{\lambda_{th}\cdot t}-1)\cdot 208 = 0.176$$

Using Aston's relative intensities $Pb_{206} : Pb_{207} : Pb_{208} = 100 : 10.7 \pm 3 : 4.5 \pm 2$ we get $Pb_{206} = 6.960$, $Pb_{207} = 0.745$ and $Pb_{208} = 0.313$ gram. For the ordinary lead Aston gives the intensities $I_{206} : I_{207} : I_{208} = 4:3:7$. Hence we can write

$$Pb_{208} = 0.313 = Th\,D + \frac{1}{2}L\ \text{(ord. lead)} = 0.176 + \frac{1}{2}L \quad \ldots.\ (1)$$

$$Pb_{207} = 0.745 = Ac\,D + \frac{3}{14}L \quad \ldots.\ (2)$$

$$Pb_{206} = 6.960 = Ra\,G + \frac{2}{7}L = 6.856 + \frac{2}{7}L \quad \ldots.\ (3)$$

and

$$Ac\,D + L = 0.986 \quad \ldots.\ (4)$$

[9] A. F. Kovarik, *Phys. Rev.* [2] 33: 1069–1070, 1929.

The amount of common lead can be calculated separately from (1), (3) and (2) + (4) and comes out

$$\begin{aligned} L &= 0.274 \text{ from } (1) \\ L &= 0.364 \quad \text{''} \quad (3) \\ L &= 0.307 \quad \text{''} \quad (2) \text{ and } (4). \end{aligned}$$

In view of the probable errors in the intensities, these results for the amount of common lead must be considered quite satisfactory.

It is evident, therefore, that in calculating either the age of the mineral or the disintegration constant of actino-uranium one must take into consideration the ordinary lead present in the mineral. That common lead may be present in bröggerites has also been shown by Professor Ellen Gleditsch.[10]

The ratio, r, of actinium: uranium is really defined by the equation

$$r \cdot \lambda_u \cdot u = \lambda_{ac} \cdot ac = \lambda_{ac\,u} \cdot ac\,u_t = \lambda_{ac\,u} \cdot ac\,u_o \cdot e^{-\lambda_{ac\,u} \cdot t} \quad \ldots . (I)$$

in which u and ac refer, respectively, to the number of uranium atoms and the number of actinium atoms under conditions of radioactive equilibrium. In experimental work in which r was determined, the whole of uranium was taken as U, and hence

$$u = \frac{U}{238.17} \cdot N \quad \ldots . (II)$$

in which U is the mass of all the uranium and N is Avogadro's number.

If $ac\,u_o$ and $ac\,u_t$ represent, respectively, the number of atoms of actino-uranium present in the mineral initially and at the time, t (time of analysis), and since Ac D is the final product of actino-uranium, then

$$\frac{Ac\,D}{207} \cdot N = ac\,u_o \cdot (1 - e^{-\lambda_{ac\,u} \cdot t}) \quad \ldots . (III)$$

From the equations (I), (II) and (III) we obtain

$$\frac{Ac\,D}{207} = (\lambda_u \cdot \frac{U}{238.17} \cdot r) \cdot \left(\frac{e^{\lambda_{ac\,u} \cdot t} - 1}{\lambda_{ac\,u}} \right) \quad \ldots . (IV)$$

Substituting into (IV) values given above and using $\lambda_u = 1.52 \times 10^{-10}\ yr^{-1}$ and $r = 0.03$ we get

$$\lambda_{ac\,u} = 2.5_4 \times 10^{-9}\ yr^{-1},$$

or

$$T_{ac\,u} = 2.7_3 \times 10^8 \text{ years}$$

If we may assume that the relative amount of actino-uranium to uranium (I + II) is initially the same in all uranium-bearing minerals (an assumption offering some difficulties) then this relative amount should change with the progress of time and r should be less in older minerals at the time of the analysis. The results below show that such a variation seems to exist.

Let t′ be the age of the mineral for which $r = 0.03$ and t be the age of the mineral for which $r = 0.08$, then

$$\frac{r_t'}{r_t} = \frac{e^{\lambda_u \cdot \Delta t}}{e^{\lambda_{ac\,u} \cdot \Delta t}} = \frac{0.03}{0.08} = \frac{e^{1.52 \times 10^{-10} \cdot \Delta t}}{e^{2.54 \times 10^{-9} \cdot \Delta t}}$$

from which $\Delta t = t' - t = 4 \times 10^8$ years.

Boltwood, who obtained $r = 0.08$, used the North Carolina uraninites (Spruce Pine), and Hahn-Meitner, whose $r = 0.03$, used "pitchblende." Ages of the minerals are not given. Kirsch, whose value of r is 0.04 and more nearly like that of Hahn-Meitner's value, used Morogoro pitchblende and also a bröggerite from Raade, Moss, Norway, whose age is, at least approximately, 8 or 9×10^8 years. The determination of the age of a North Carolina uraninite (Flat Rock Mine) yields a very much lower age. If the ages were accurately known, it is not improbable that the difference in age may be such as to account for the different value of the ratio obtained by Boltwood and by Hahn-Meitner or by Kirsch or by S. Meyer.

Two minerals, namely, uraninite from Keystone, South Dakota, and uraninite from Sinyaya Pala, Carelia, supply data which with some assumptions, reasonable for these two minerals, may be used to produce a check on these deductions. The ages of these minerals by the above "age formula" come out, respectively, 1465×10^6 yr and 1852×10^6 yr and the corresponding values of L(= ordinary lead + some Ac D) are 0.67 and 0.91. Considering the great ages of these minerals and also the relatively more rapid rate of disintegration of actino-uranium than of uranium, it is highly probable that a greater part of the "L" is Ac D in the case of these minerals. In any case the error will not be great to assume this. Correcting also Ac D by a fraction

$$\frac{r \cdot U}{238.17}(e^{\lambda \cdot t} - 1) \cdot 206$$

we have

$$Ac\,D = L + \frac{r \cdot U}{238.17} \cdot (e^{\lambda_u \cdot t} - 1) \cdot 206$$

$$= 207 \cdot (\lambda_u \cdot \frac{U}{238.17} \cdot r) \cdot \left(\frac{e^{\lambda_{ac\,u} \cdot t} - 1}{\lambda_{ac\,u}} \right) \ldots . (A)$$

which can be solved for r. We can also calculate r from the difference of age of the mineral under consideration and the age of a mineral for which $r = 0.03$. For the latter age we may use the approximate value 8×10^8 years. We get

[10] Ellen Gleditsch, *Skrift. Norsk. Vidensk. Akad. Oslo*, No. 3, pp. 1–49, 1925.

$$r = 0.03 \cdot \left(\frac{e^{\lambda_u \cdot \Delta t}}{e^{\lambda_{ac\,u} \cdot \Delta t}} \right) \quad \ldots . (B)$$

in which Δt = age of mineral considered minus 8×10^8 years.

The essential data for these minerals are:

Keystone, S. D., uraninite:
$U = 66.90$, $L' = 0.67$, $t = 1465 \times 10^6$ yr.
Sinyaya Pala, Carelia:
$U = 61.41$, $L' = 0.91$, $t = 1852 \times 10^6$ yr.

The results of such calculations are:

Mineral	r from (A)	r from (B)
Uran. Keystone, S. D.	0.0053	0.0061
Uran. Sinyaya Pala	0.0027	0.0024

We see that the two calculated values in the case of each mineral check reasonably well. It is also evident that r for the Keystone mineral is a little more than ½ per cent. and for the Sinyaya Pala about ¼ per cent. It is to be noted also that the difference of age of these two minerals is roughly 4×10^8 years. Considering these results it would be desirable to have the experimental values of r from these minerals.

The following general conclusions about actino-uranium seem plausible:

(1) Actino-uranium seems to be an independent isotope of uranium.

(2) Its disintegration constant is about $\lambda_{ac\,u} = 2.5 \times 10^{-9}$ yr^{-1} or $T = 2.7 \times 10^8$ years.

(3) Its amount in minerals appears to conform to the idea that it is initially of a definite amount in proportion to the uranium and that this relative proportion decreases with the age of the mineral.

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ON THE MECHANISM OF BIOLOGICAL OXIDATION AND THE FUNCTION OF THE SUPRARENAL GLAND

CLINICAL and experimental observations on the symptoms of suprarenal deficiency have indicated that the suprarenal gland is in some way involved in the mechanism of oxidation. For this reason I have studied for many years processes of oxidation, with the hope of finding the clue to the function of the cortical part of the gland. Vegetable tissues were used in these studies to a great extent.

Most of the common plants and fruits can be divided into two main groups: those which show discoloration on injury (apple, banana, potato), and those which do not (lemon, orange, cabbage).

Extending earlier observations of Palladin and M. W. Onslow, it was found[1] that the most prominent oxidation system of tissues which discolor on injury is the so-called phenoloxidase system. This system consists of a phenoloxidase and a phenol, which latter is a derivative of catechol and is chemically closely related to epinephrin. In the presence of molecular oxygen, this phenol is oxidized by the phenoloxidase to an ortho-quinone. In the intact tissue, this quinone is rapidly reduced by hydrogen, which is derived from the foodstuffs. If the tissue is injured, this reduction does not take place; the quinone remains in the oxidized state and undergoes secondary changes, or combines with other cellular constituents. The quinones and their secondary products are highly colored and thus cause discoloration of the tissue.

It is known that quinones have a very high bactericidal power. It has been shown in the latest experiments on potatoes that injury to the tissue leads to increased oxidation of the phenol and therefore to increased production of quinones, so it seems probable that the phenoloxidase systems also play a part in the natural immunity of plants which contain this oxidation system.

Most vegetable tissues which do not have the phenoloxidase system and which do not discolor on injury contain a highly active peroxidase and very little catalase. Further investigation has shown that these tissues also contain, in relatively high concentration, a substance which is characterized by its strong reducing properties. This substance has been isolated in crystalline form and has been found to be a hitherto unknown compound related to the carbohydrates. This acid is an isomer of glucuronic acid and has been named "hexuronic acid." This acid shows quite unexpected activity. It reduces salts of silver even in the cold and in an acid solution. It is the most reactive derivative of the carbohydrates hitherto discovered and prepared in free condition.

The most striking property of this substance is its reversible oxidizability, by which two of its hydrogen atoms can be split off in a reversible way. The substance owes its high reactivity to these two labile hydrogen atoms, and not to the carbonyl group.

The latest studies performed on cabbage leaves have brought out the fact that in this plant hexuronic acid plays a central rôle in normal respiration. It has been shown that the cabbage leaf contains a very active enzyme which oxidizes hexuronic acid at a high rate, oxidizing off its two labile hydrogen atoms. The oxidized hexuronic acid is then again reduced. In this way, the hexuronic acid connects as a hydrogen car-

[1] A. Szent-Györgyi, "Über den Oxydationsmechanismus der Kartoffeln," *Biochem. Ztschr.*, 162: 399–412, 1925.

rier, on the one hand the oxidation systems which utilize oxygen, and on the other the foodstuffs which are the source of hydrogen.

The enzyme responsible for the rapid and reversible oxidation of hexuronic acid has been called "hexoxidase." Its properties are different from the properties of other known oxidizing enzymes. Study of the kinetics of this enzyme has clearly shown that this enzymic function is a complicated one and that the hexuronic acid is not immediately oxidized by the enzyme. The enzyme contains a special substance or grouping, "x," which is first oxidized by the oxygen. This oxidized "x" then in turn oxidizes the hexuronic acid and is itself reduced again. No cyan-sensible oxygen activation is involved in the oxidation of "x," so that this oxidation probably goes hand in hand with the formation of hydrogen peroxide. This would explain the presence of the highly active peroxidase which would complete the system, utilizing the peroxide thus formed.

Extending these studies to the suprarenal gland, it was found that the suprarenal cortex contains a strong reducing agent, the high concentration of which is sharply characteristic for this organ. This substance has been isolated in crystalline form and has been found to be identical with the hexuronic acid from plants.

Hexuronic acid completely inhibits formation of pigment in all systems in which a "melanoid" pigment is formed through the oxidation of a phenol. In biologic systems a minimal concentration of hexuronic acid is sufficient to give complete inhibition. The absence of hexuronic acid in Addison's disease could give thus a clear explanation of the mechanism of formation of pigment.

Experiments, however, performed on animals after extirpation of the suprarenal glands, have shown that hexuronic acid is unable to prolong life. Hexuronic acid given in two cases of Addison's disease seemed to have some beneficial effect but did not restore the patients to full activity. It seems to be certain, therefore, that besides hexuronic acid some other substance is elaborated by the suprarenal cortex to which this organ owes its vital importance. The formation of pigment, however, which in Addison's disease is not dependent on the gravity of the case, seems to be connected with hexuronic acid. It seems to be highly probable that the other hitherto unknown product of the cortex plays in the animal tissue a part analogous to that of the "x" substance of the oxidation system of the cabbage leaf, which has been mentioned.

The careful survey from a chemical standpoint of reducing substances of the suprarenal gland also has brought out the fact that the medulla contains, besides epinephrin, a strong reducing agent which is specific for the medullary tissue. The substance has not yet been isolated. In many ways its behavior is analogous to that of hexuronic acid, but it seems not to be identical with it. This substance also inhibits formation of pigment, and it is possible that its absence also is a factor in the production of pigmentation in Addison's disease. It is possible that both reducing substances, hexuronic acid and the reducing substance of the medulla, play an important part in the stabilization of the other active principles present (epinephrin and the unknown hormone of the cortex). It can easily be shown *in vitro* that epinephrin is highly autooxidizable at the hydrogen-ion concentration of the tissue. The oxidized molecule rapidly undergoes irreversible secondary changes. In the presence of hexuronic acid or in the presence of the reducing substance of the medulla the oxidized molecule of epinephrin is at once reduced again and is protected in this way from secondary irreversible changes.

There are thus four specific substances elaborated by the whole suprarenal gland. In the medulla are found epinephrin and a strongly reducing substance. In the cortex are found hexuronic acid and the probable presence of another active principle, the existence of which seems to be established by the recent work of Hartman and his collaborators, of Stewart and Rogoff and by the most recent investigation of Swingle.

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GLOZEL, A MYSTERY[1]

By Dr. DAVID RIESMAN

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THOSE who have read something about Glozel may wonder why I speak of it here. Is it not a dead issue? No, for as a study of human credulity and as a commentary on the hot-headedness or should I say pig-headedness of many men of science, it will always occupy a prominent place in the history of civilization.

Although many of the audience are probably familiar with the main facts, I want to give a brief synopsis of the involved story. I say "story" advisedly, for from the very outset the mystery of Glozel has formed a fascinating tale, very much in the genre of our best thrillers, with plot and counter-plot, gum-shoe detectives and all the pertinent paraphernalia.

Glozel is a small hamlet of four farmhouses, about fifteen miles from the famous spa of Vichy. Emile Fradin, then a youth of eighteen and belonging to an old local family, was one day working in his grandfather's field when a cow suddenly slipped into an unsuspected hole. Fradin went to investigate and found that the hole led into an oval pit containing a variety of remarkable objects—bricks, tablets, vases—which he gathered and as soon as possible showed to the village schoolmistress, Mlle. Picandet. The latter in turn showed some of the tablets to M. Clément, a school teacher in la Guillermie. Eventually the news of the discoveries came to the ears of Dr. Albert Morlet, a surgeon of Vichy and an amateur archeologist. Thereafter Dr. Morlet and Emile Fradin together began to excavate at Glozel and brought to light more and more buried objects which they collected in grandfather Fradin's house and which Dr. Morlet described in detail in an endless series of articles in a literary journal, the *Mercure de France*. It was through this magazine—the *Atlantic Monthly*

[1] Read by invitation before the American Philosophical Society on April 24, 1930.

of France in more senses than one—that I became interested in the Glozelian discoveries. My interest was especially aroused by the claim of Morlet and others that an alphabet had been discovered at Glozel which antedated every other alphabet then known. I therefore decided while spending a vacation in the Auvergne to see Glozel for myself, but before doing so I determined to interview Dr. Morlet in Vichy. At first he suspected me of being an archeologist, but when in answer to a direct question I denied the soft impeachment and proclaimed myself merely a doctor, he became cordiality itself and showed me his collection of Gallo-Roman and Glozel antiquities. He told me that he as well as others had been inclined to consider Glozel as belonging to the Magdalenian age because of the presence of harpoons and of stones engraved with reindeer and other animals long extinct in France, but further studies had led to the conclusion that Glozel was Neolithic. Dr. Morlet kindly asked me to stay over until the following day and dig with him and Professor Björn, of Sweden, but I was unable to do so.

After leaving Morlet I motored, together with two American friends, to Glozel. Emile Fradin received us and at once offered to take us to the field of excavation. It was at the bottom of a deep ravine and was surrounded by a barbed-wire fence and scarred by trenches and holes. He showed us the original oval pit and the two tombs subsequently discovered. As it was raining hard and as the clayey ground was slippery, I declined his invitation to crawl into one of the tombs but asked instead to see the museum. After paying two francs each we entered through a low door above which was a crude sign with the pretentious words, *Musée de Glozel,* and found ourselves in a square low-ceilinged room with shelves on the walls and very primitive glass cases standing on the floor. The objects exhibited on shelves and in cases were astounding in number and variety—vases, tablets, engraved stones, ornaments especially pendants, some pieces of glass and harpoons, the last not nearly as artistic as those of Magdalenian age I had seen at Les Eyzies and at Laugerie-Basse. Three articles attracted my special attention—vases or vase-like pottery-ware having eyes, nose and ears but no mouth, which Morlet has called death masks, explaining the absence of the mouth by assuming that the primitive makers wanted to express the silence of the grave. Secondly, a squarish object suggesting the female figure with a cylindrical projection from the forehead interpreted as the phallus—this Fradin told me was a bisexual idol; and most striking of all, clay tablets with graven signs looking in every way like alphabetical characters. I was struck by the clean red color of these tablets. When I spoke of this to Fradin, he explained it by saying that the soil in which the tablets had been found was such that it did not readily fuse with the clay and hence was easily brushed off. There were also some large casts of the human hand which differed from the imprints of the hands in the Spanish and French caves in having all the fingers present.

I offered to buy some of the articles, especially a tablet, but Fradin resolutely refused to sell. During the whole of our stay in the museum, the grandfather stood silent and motionless in a doorway leading to an inner room.

The reputed discoveries of an alphabet dating back to Neolithic times of which I had now seen the alleged evidence in abundance created a tremendous sensation in informed circles. Altogether about 136 characters had been distinguished, representing every letter of the alphabet except the letter B.

Hitherto the credit for creating an alphabet had been given to the Phoenicians, but the oldest known Phoenician record found at Byblos a few years previously dated back only to about 1300 B. C.; Sir Arthur Evans's baffling Cretan inscriptions of ninety characters, to *ca.* 3000 B. C. If Morlet and those who agreed with him were right, then Glozel was truly what M. Reinach called it—one of the greatest archeological discoveries of all time.[2]

Almost immediately after the first appearance of Morlet's reports, doubts began to be voiced about the authenticity of Glozel, though in the early period of the controversy there were perhaps as many scientists who accepted the discoveries in good faith as there were doubters. Soon the pro- and anti-Glozelians became personal and attacked each other with a vituperative vehemence and a destructive sarcasm for which the French language appears to be the ideal medium. Reputations were shattered, old friendships broken, and—as one of the French dailies remarked—even butcher boys came to blows on the streets of Paris.[3] In fact Mrs. O'Leary's cow did no greater damage to Chicago than Fradin's to the reputation of some French savants.

Before long the leading French prehistorians with only an occasional exception began to deny altogether the authenticity of Glozel and to declare the excavated articles to be forgeries. A number of Englishmen were likewise unconvinced. However, Dr. Foat, a London scientist, makes the categorical statement that "if the finds of Glozel are not authentic, it is equally necessary to consider as false all that I have seen in

[2] Dr. Hackh in an exhaustive essay on the "History of the Alphabet" makes no reference to Glozel; if true, Glozel belongs at the very bottom of the linguistic tree.

[3] The Glozel affair has been made the subject of biting burlesque performances in Paris theaters and is the theme of a sarcastic novel by René Benjamin.

museums between London and Constantinople." Several Scandinavian, Belgian and Portuguese scientists also supported Dr. Morlet, and a German, Dr. Wilke, in a recent article enthusiastically upholds the standard of Glozel.

Are Dr. Morlet's supporters right or is Glozel but one more of the long series of frauds that history recounts since Jacob imposed upon his father Isaac? Many will come to your minds—Thomas Chatterton, our own Dr. Cook, Constantine Simonides, the pretended author of the Codex Sinaiticus, the forger of the Mecklenburg Declaration, the Lincoln love letters in the *Atlantic Monthly,* the Tiara of Saitapharnes, Ferrante Stocco, the Calabrian priest who created a saint, Giovanni Cala, and invented a life for him, and countless others. Two perhaps are germane and worth recounting. In the early eighteenth century George Psalmanazar, born in the south of France, came to England and with the connivance of a rascally clergyman, Alexander Innes, proclaimed himself a native of the Island of Formosa. He was lionized in London, wrote a description of the island which he had never seen and included in the book an alphabet and grammar of the Formosan language. Though many doubted his veracity, the book passed through two editions and was translated into French. Toward the end of his life he revealed himself in his own memoirs as a colossal faker and declared that all he had published including the language and the grammar was a hoax.

One of the most interesting cases and the one having the greatest analogy to Glozel, if Glozel be a fake, is that of the so-called "Figured Stones of Wurzburg."

In the first half of the eighteenth century there lived in Wurzburg, in Bavaria, an ultra-pious physician named Johann Bartholomaeus Adam Beringer. He is not remembered for any great discovery or contribution to science, but for his share in a remarkable scientific hoax. At the time in which Beringer flourished an active discussion was going on as to the source and meaning of fossils. Although Leonardo da Vinci had understood their true nature—even Herodotus, 400 B. C., had a correct idea—the scientists of two hundred years ago accounted for them as the result of "stone-making forces" of "formative qualities" or as growths from seeds. We may be inclined to smile, but with Dayton in Tennessee to chasten us, we can not throw stones at the Wurzburg of two centuries ago or at the Sorbonne which a hundred years later deprived the great Buffon of his chair because of his heterodox views.

Beringer had committed himself publicly to the belief that fossils were the capricious fabrication of God, hidden by Him in the earth for some inscrutable purpose. His zealous maintenance of this fundamentalist position led some of the students together with members of the faculty and wags of the town to make numerous fossils of clay which they buried in the side of a hill where they knew the professor was wont to search for specimens. Beringer chancing upon these objects was completely deceived. The jokers then became bolder and buried the most extraordinary and extravagant figures their whimsical imagination could suggest. They fashioned tablets bearing inscriptions in Hebrew, Babylonian, Syriac and Arabic and buried them not far from the original spot. Beringer was overjoyed to find such abundant confirmation of his doctrines, and forthwith in true German fashion proceeded to write an exhaustive treatise. The wags now began to realize that they had gone too far. They expostulated with him and revealed to him the whole truth. Instead of believing them Beringer became more than ever convinced that the story his frightened colleagues told was a ruse to rob him of the honor of his discoveries. No one could stop him. At great expense he published in 1728 the "Lithographiae Wirceburgenses."

Only too soon the shout of laughter with which the book was greeted brought the truth home to him. In chagrin and despair he exhausted nearly his entire fortune in a fruitless endeavor to suppress the edition and to buy up the copies already issued. He died soon afterwards, it is said, of a broken heart.

Is Dr. Morlet like Johann Beringer the victim of deception? Upon me personally he made the impression of an honest man. In certain quarters he was accused of fraud, for example, by the *Journal des Débats* and by the French Society of Prehistory. He promptly brought suit against these and won a verdict of 1,000 francs damages. The defendants carried the case to the Court of Appeals at Riom, the native town of Willa Cather's lovable archbishop. In confirming the verdict, the court gave expression to an amusing quibble. It held that Morlet, being a surgeon by profession and only by avocation a prehistorian, was not injured in the eyes of his real colleagues but only as an amateur archeologist. But as the defendants had not actually proved fraud, they were declared guilty of libel though the fine was reduced to one franc and costs.

Another humorous episode might be mentioned. Regnault, president of the French Society of Prehistory, sued a M. X— because he, Regnault, had been compelled to pay the sum of four francs to see a collection of fake objects. As part of this legal action, the police of Moulins broke into Fradin's premises and took away a number of objects which were afterwards submitted to the public expert, M. Bayle. The latter reported that the tablets were of

recent manufacture. Pieces of clay from a tablet crumbled readily in water; hence it was not conceivable that the tablets could have resisted the moisture in the ground had they been there for many years. Furthermore, a bit of grass picked out of a piece of earthenware showed under the microscope vegetable cells and chlorophyl,[4] and some of the bone instruments still contained marrow. Bayle was soon afterward shot to death by one Philopponet against whom he had testified in court.[5]

The Fradins themselves brought suit against M. Dussaud, member of the Institut, who in a trenchant brochure had called them fakers.

Let us now delve a little more deeply into this mystery so that we may understand better the basis of the whole controversy. The first serious doubt as to the authenticity of Glozel was based on the heterogeneity of the articles in Fradin's museum. How could one explain the presence of so many dissimilar and unrelated objects in one small field of excavation —the two or three thousand at the time of my visit have now grown to five thousand? No other archeologic site offers a parallel. Morlet answered this by saying that Glozel was a *champ des morts,* a cemetery, and that, as among many primitive peoples of later times, everything belonging to the dead had been buried with him. C. Jullian, who considers Glozel a Gallo-Roman station, accounts for the multiplicity of objects on the assumption that Glozel was a sorcerer's sanctuary. He has added greatly to the gaiety of nations by attempting a full translation of the inscribed tablets from the published illustrations. Dr. Morlet showed me with much amusement a crack in one of the tablets which Jullian had translated as a character.

Aside from the puzzling complexity of the collection, it has been pointed out that the tablets first exhumed bore fewer and less perfect characters than the later ones. Further, as soon as some one had made a criticism, the objects next exhumed would often be free from the criticized defect. Quite frequently certain features appeared that could be traced directly to scientific articles published shortly before. These facts seem of course very significant. Moreover, the scratches on stones whether representing animal figures or alphabetic characters were without the patina covering other parts of the stones, suggesting a recent production. Much was made of the penetration of roots into vases or tablets; but upon examination these roots were not found to be properly fossilized, which would have to be the case had the objects been in the ground for long ages. The utensils—harpoons, hand-axes, scrapers—are far less artistic than those in other Neolithic stations. Vayson de Pradenne and Abbé Breuil indeed contend that none of them could ever have been used.

Dr. Morlet and his chief supporter Van Gennep did their best to answer all these objections. The former at the height of the verbal battle-royal made a request for a governmental commission which was speedily granted, but when he found that a bitter anti-Glozelian, the well-known archeologist Capitan, was a member, he objected and the commission was never sent. Eventually, at the International Anthropological Congress at Amsterdam an International Commission was formally appointed to investigate Glozel. The commission consisted of Absolon, director of the Archeological Museum of the State of Moravia; Bosch Gimpera, professor in the university and director of the archeological work of Barcelona; the Abbé Favret; Forrer, director of the Prehistoric and of the Gallo-Roman Museum at Strasbourg; Miss Dorothy Garrod, member of the Royal Anthropological Institute and of the French Prehistoric Society; Hamal-Nandrin, lecturer on prehistory in the Museum of Liége; Peyrony, director of the Museum of Les Eyzies, and Pittard, professor of anthropology in the University of Geneva. Absolon was prevented from taking part in the work of the commission.

After spending three days at the site the commission issued a unanimous report which was kindly sent to me by Miss Dorothy Garrod. This report states unequivocally that the articles are for the most part of recent manufacture and have undoubtedly been planted in the ground by some one whom the commission does not name, and that Glozel is neither prehistoric nor authentic. Vayson de Pradenne, in a devastating brochure in which he declared the Glozel finds fakes, also accused no one by name but put the blame upon the *esprit de Glozel*—in other words, upon a fairy.

One might think with the leading French, English and American scientists—Peyrony, Pradenne, Abbé Breuil, Sir Arthur Evans,[6] Dussaud and, I believe, Professor MacCurdy—arrayed against Glozel, and with the destructive judgment of the international commission, that Glozel would cease from troubling the scientific and the lay mind. Though all due

[4] A report has just been made to the Académie des Sciences (*Mercure de France,* May 1, 1930; *La Dépêche de Vichy,* April 12, 1930) of the finding in Russia of chlorophyl in fossil plants of the Tertiary epoch, millions of years old.

[5] Bayle's reputation has been seriously tarnished through recent posthumous revelations. He suffered, as one writer puts it, from "mercantilitis," a post-war malady. A number of years ago he divorced his wife so as to consecrate himself solely and wholly to science. "I shall not remarry," he exclaimed. Nevertheless he took another wife soon afterwards. The first wife was unaware of this, for he continued to visit her every evening during a period of seven years.

[6] Personal communication.

obsequies have been performed, Glozel refuses to remain in its sepulcher, and the literary battle continues. Dr. Morlet very kindly sends me newspapers and pamphlets, and a distinguished pro-Glozelian of Belgium, Professor Tricot-Royer, has just supplied me with his defense of Glozel which is particularly interesting because Professor Tricot-Royer was present during the visit of the international commission.

What keeps Glozel alive? First, we have the fact that when men take sides in print they are loath to recant, fearing ridicule—the more untenable their position, the more stubborn their resistance.

Secondly, six months after the international commission's visit Dr. Morlet called together a *comité d'études* of twelve men, consisting of Dr. Foat, Bayet and Tricot-Royer, of Belgium; Reinach, J. Loth, W. Loth, Van Gennep, Deperet, Ajcelin, Roman and Audollent, of France, and Soderman, of Sweden. At their meeting they pronounced unanimously in favor of the genuineness of Glozel.

Another reason is found in the attitude of a group of French and German scientists who are opposed to the traditional belief that *ex oriente lux*—that civilization is of oriental origin. The alleged Neolithic alphabet of Glozel and similar finds at Alvao in Portugal are grist to their mill.

In addition quasi-political factors have entered into the controversy—Fradin an obscure peasant, Morlet a provincial doctor without much influence have a definite appeal for the proletariat and for a large section of the press.

And finally, it must be remembered that the Academicians are not always right—that they ridiculed Pasteur and Boucher des Perthes, and that even Koch and Lister met a similar fate in the beginning.[7]

All these elements cooperate to keep the spark of life in Glozel. Within the past few weeks the publication of an exhaustive treatise by Dr. Morlet has been announced. This, however, I fear, can throw no new light upon the subject.

As a detective tale the story of Glozel remains unfinished and will remain so until a Sherlock Holmes discovers the supposed person or persons who manufactured the articles and put them in the ground. What was the motive? How are we to explain the extraordinary industry that has fashioned five thousand or more articles, and how is it that he, the *esprit de Glozel*, escaped detection in a community of twenty-nine souls where every one knows every one else's business? Or how, if there are witnesses to the dark deed, can we explain an unbroken neighborly silence extending over a period of six exciting years?

PREPARATION OF SCIENTIFIC ARTICLES

By W. M. DAVIS

PROFESSOR OF GEOLOGY, EMERITUS, HARVARD UNIVERSITY

Recollections of many untrained efforts and of many changes in methods of writing scientific articles prompt me to set down some of the more profitable results of a rather long experience in that sort of work, in the hope that they may prove useful to others.

The Article

After the subject of an article has taken shape in the mind and the general sequence of its headings has been planned, cut some typewriter paper in half and write brief statements of the leading points on separate half pages. Never begin a second paragraph on the same page with the end of the preceding one. Do not hesitate too long over the precise wording of this first draft; set ideas down as they take form; revise, clarify and compress the wording afterwards. Arrange the pages in a logical order, number them 5, 10, 15, 20, and so on, and make out a provisional table of contents. Changes and additions which require the rewriting of paragraphs and the later insertion of afterthoughts with intermediate paging are thus much facilitated.

Carry a blank book with the growing manuscript—an examination blue-book will serve—and keep a record of work done on its first pages. Besides mention of whatever occurrences led up to the preparation of the article and notes on the incidents of its progress, the following dates should be entered: Beginning and ending of the rough draft; making first clean copy, and second also if a second prove necessary; sending copy to the publisher and acknowledgment of its receipt; arrival and return of galley proof and page proof; appearance of article; receipt and distribution of reprints. The more significant of these notes and dates should be later copied off in good form and pasted, with a list of correspondents to whom reprints are sent, in the reprint kept in one's own file. Much do I regret not having such a

[7] Recently the Geological Society of Normandy (*Mercure de France*, April 15, 1930) has formally proffered "ses plus vives félicitations" to Dr. Morlet for his science, his tenacity and above all for the magnificent energy with which he has faced the attacks and unjust calumnies to which he has been subjected and which the Court of Appeals at Riom has definitely condemned.

set of records, one for each reprint on my personal book-shelf.

On later pages of the same blank book enter all questions which arise during composition or revision of the manuscript and for which answers have to be searched in various sources. Both questions and answers should be written out rather fully, so as to avoid misunderstandings and errors. Do not trust to scraps of paper for these memoranda; enter them all, both questions and answers, in the blank book in orderly form. If scraps are used much time is lost in re-search in case they are accidentally mislaid.

When the time comes for making the first clean copy of the apparently completed manuscript, examine the periodical to the editor of which the article is to be offered for publication, and thus learn the form in which "copy" should be prepared for its pages; for example, whether a summary or a table of contents should be inserted at the beginning; whether references should be made by star and dagger signs, by numbers to numbered foot-notes, by numbers to a numbered bibliographic list at the end of the article, or otherwise. Then prepare the rough manuscript accordingly for clean copy on full-sized sheets, and the editor will be grateful. My own preference as to references is to place a list of all articles cited, arranged alphabetically by author's names, at the end of the manuscript; and when an author's name or a citation of his writings appears in the text, add a parenthesis containing the year in which his article was published and the page on which the cited passage is found. This avoids the repetition of a title in successive foot-notes when the same article is referred to several times, and also does away with those inconvenient abbreviations, *loc. cit.* and *op. cit.*

Faults of style and arrangement that passed unnoticed in a first rough draft often become rather glaringly visible in a clean copy, and it therefore soon becomes more or less disfigured with erasures and interlinings. As clearness of text is more important than elegance of appearance, it usually suffices to typewrite the disfigured parts in close lines on narrow strips and paste them over the disfigurement; a good deal of unnecessary copying is thus saved. When this stage of improvement is reached, it is a good plan to lay the article aside for a week or a fortnight, and then read it aloud to some patient listener. The main thing to consider at this time is whether the style is as concise as possible and whether the subject has been presented in such a manner that a reader not familiar with its details can comprehend it. His honorable points of ignorance must be carefully enlightened, and a listener is likely to be helpful in showing where enlightening suggestions are needed. So many improving changes may be thus made, especially if the article is argumentative, that a second clean copy has to be prepared. This causes some delay which an enthusiastic author may not enjoy; but the world will have already waited so long for his article that a little longer waiting will not cause wide-spread discontent.

BIBLIOGRAPHY

Whenever a book or article is consulted and an extract is made from it, enter the name of the author, title of the article and its source, as well as all abstracts and quotations with their pages, on a slip about the size of a postal card (several slips may be needed for long excerpts). Then compare every word with the original; if found correct make a nick (√) opposite name, title, source and each quotation. When final clean copy is made and when proof is received, compare all citations with these authenticated slips and thus save many hours of fatiguing labor that would otherwise be demanded by returns to the original sources for verification. If an author has two initials before his family name, they suffice to identify him; if only one, his first name should be given. Thus, J. B. Hazelton, but Thomas Simonds. If a book is consulted, its place and year of publication should be noted.

It would be a good thing if the National Research Council would propose a standard form for bibliographic references; and if they do so I beg leave to suggest that they recommend Arabic numerals for volume numbers, omit parentheses enclosing dates and discard Vol. and pp. Thus if the abbreviated name of a periodical is followed by the figures 38, 1924, 263–279, no uncertainty can be felt as to their meaning. The first number, 38, can mean only the volume; the second, only the date of publication, and the last two numbers, only the first and last pages of the article cited. In case Vol. and pp. are retained, why not insert A. D. before the date and use Roman numerals for the volume? Then the same reference would read: Vol. XXXVIII, A. D. 1924, pp. 263–279, and would occupy almost double the space of the more condensed reference. If a periodical groups its volumes into successive series, the number of the series need not be quoted, because the year suffices to indicate the volume intended. But until a standard form for references is introduced and adopted, the style of references used in the publication of the author's choice should be followed.

Professional bibliographers and library cataloguers are of course expected to transcribe the entire title of an article or book, however long it may be; but a scientific author may be excused if he condenses an overlong title to a reasonable shortness, the omitted parts being indicated by dots. I do not know how

others feel about it, but my patience is always tried by titles of twenty words or more. Here are two samples, paraphrased from actual titles: "Outline of the mountain forms on the south coast of Labrador, with special attention to the littoral outcrops of Devonian strata"; and "Preliminary notes on the geology of the Marquesas Islands, with particular consideration of the Mehetian and Paumotuan dolomites." They might be advantageously reduced to "Mountain forms in southern Labrador" and "Geology of the Marquesas Islands." If an author regards further details as indispensable, let him show consideration for those who wish to cite his work by dividing its title into a main and a subordinate heading; for example, "The south coast of Labrador, with an outline of its mountain forms and an account of littoral Devonian outcrops." Then only the first five words need be quoted; a few dots will show that more title follows, unquoted. But if an author thus condenses the title of other writers' articles, let him take care to compress the title of his own articles into the fewest possible words. A title should not be a table of contents but only a concise name, easily cited. On the other hand, it should not omit essential words; for example, "Fossils of the Dobreva formation" is not so intelligible as "Lower Triassic (Dobreva) fossils from Nevada."

Condensation of unreasonably long names of periodicals is also advisable, if for no other reason than to persuade their editors to adopt shorter names. Why, for example, can not the University of California be satisfied to have its excellent geological bulletin referred to as "Univ. Calif. Geol. Bull." instead of asking that it should be cited as "Univ. Calif. Publ. Bull. Dept. Geol. Sci." The fact that the bulletin is published by the department of geology—if such be the case—is merely a local administrative detail, of little or no interest in geological science. The complete title is, indeed, so long that it has to be abbreviated in its own page headings, and even the graduates who contribute to it do not always cite it correctly! And yet six of the abbreviated words are dutifully cited in the invaluable Bibliography of American Geology, published as Bulletin 746 of the U. S. Geological Survey, which otherwise carries abbreviation to its farthest reach; B means Bulletin; J, Journal; Ac, Academy; Am, American; Pr, Proceedings; Sc, Science, and so on.

Quotations between inverted commas should follow the original passage with scrupulous care, even to the point of reproducing incorrect spelling. Omissions from quoted passages should be indicated by dots; additions to them should be enclosed in square brackets.

Illustrations

When it comes to the preparation of illustrations, cut a rectangle of paper the size of a page in the selected journal of publication, and trace on it the outline of the space given to the printed text. Illustrations should then be drawn so as to fit that space, which is generally narrower than it is imagined to be. Whatever the height of a figure, its width should as a rule be that of the printed page, like Fig. 1, *A*. If smaller it should be only about half as wide, like *E*, so as to leave sufficient room for text alongside of it. If an extra-long figure is needed, it may be drawn in two halves, to be set opposite each other

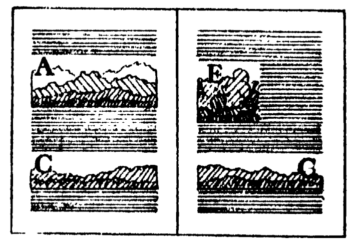

Fig. 1

on facing pages, like *C*, *C*, each half being as wide as the printed page—always provided the editor will permit so unconventional an innovation.

In order to know which one of the above sizes is best for an illustration, outline it roughly on as small a scale as it will bear. Then draw a rectangular frame around it of the size selected. From this construct a pencil frame two or three times as large on smooth, hard-surfaced paper, and outline the drawing carefully in pencil in the space thus defined. Omit unnecessary marginal lines, in order that the essential part of the drawing may be on as large a scale as possible. Set the outline aside for a day or two, so that on coming back to it with refreshed eyes it may be critically examined and improved before it is finished in smooth, firm, jet-black ink-lines with a fine pen. The frame also may be inked with a ruling pen if desired. Do not ink any lines so close together that the narrow white space between them will be blurred or lost when the drawing is photographically reduced to smaller scale in a process cut.

If a mistake is made in inking, do not erase it, but first rub out all near-by pencil lines, then paste a slip of opaque white paper over the mistake, and correct it after the slip is well dried. Be careful that the paste does not overrun the edge of the slip; if it does, ink lines will blot there. In pasting the slip on the drawing, lay a cover-paper over it and rub down the cover paper, not the slip. If explanatory letters are needed on the drawing, take from the waste-

basket an advertising pamphlet; cut from it plain capitals of sufficient size—they need not be A, B, C, D; any other letters will do as well; and paste the letters on the drawing. Erasure of pencil lines before pasting is advisable, because if a pencil line is accidentally covered by paste, it can hardly be erased. Do not guess at the size the letters should be; find some journal in which the illustrations are satisfactorily lettered, and enlarge the height of the letters as much as the drawing frame was enlarged; then search for letters as nearly as possible of that enlarged height. If names must be added, print them in unshaded Roman letters, **BbRrKk**, without serifs. Here again, do not guess at the size of the letters, but determine the proper size by enlarging good hand-printing on a figure in some book.

Do not print or write the title of a figure inside of its frame; the title will look much better if set up, in type below the figure and printed with it. When a drawing is finished and unnecessary blank paper is trimmed off, paste it at the corners on a blank half sheet. Below it draw a line, crossed like a T at its ends, to show the width to which the drawing is to be photographically reduced. Below this line write the title of the figure and any explanatory legend that is to be printed with the title. Wait until the final copy of an article is about to go to the publisher before numbering the figures and inserting the numbers in the text. Then add to the half-sheets which carry the drawings the figure numbers and the number of the manuscript page where each figure belongs. Finally, write out a list of the figures with their numbers and titles and add the list to the clean copy of the manuscript. If it is proposed to have photographs reproduced in half-tone illustrations, be sure that they are worth reproducing. Many poor photographic views have been undeservedly immortalized in recent years of inexpert Kodakery. Better than a poor photograph is an outline neatly traced from it.

If a book is contemplated, the larger it is to be the more all the above suggestions or their equivalents should be emphasized. The record book, the orderly listing of all questions in it for which answers have to be looked up, the careful authentication of titles and quotations, the adjustment of illustrations to pages, all gain greater and greater importance as the size of the book increases. The advice but not the dictation of an experienced publisher regarding the form and style of the book is valuable; and this advice should be sought early, in order that the work done in composition and illustration should be properly directed toward its goal.

When galley proof is received, indicate the position desired for each illustration on the margin. If page proof is seen later, some figures may be found on the back of the page that carries their text. It is then desirable to rearrange the text if possible by shifting paragraphs so as to bring the figure and its explanation together. If an order for reprints is given, be sure to request that the pages of the reprints be neither rearranged nor renumbered; the reprints should be exact duplicates of the article as originally paged and printed. If a cover is ordered it should bear the title of the article and the author's name, and the name of the journal of publication, with its volume and year, and the first and last pages of the article. It is desirable that the author's address should also be given, for it is very likely unknown to some of those to whom reprints are sent.

The plan of work outlined above may be called methodical; and some writers, deeming themselves unmethodical, may regard the plan as too systematic for their adoption. Yet it is particularly to such writers that the plan is submitted, for I began unsystematically myself and long failed to form orderly habits of work—in consequence of which I have had to retrace many steps and reopen many books needlessly. A little patient practice on the plan here set forth or on some other consistent plan can not fail to be serviceable to many a young scientist in reducing accidental and more or less disorderly habits of work to more orderly and time-saving habits. The use of half-sheets is a very helpful device, especially in the early stages of composition; the addition of authenticating nicks on reference slips, soon becoming habitual, will save hours and days in verifying quotations. One more suggestion in closing: condense all manuscripts as much as is reasonably possible.

OBITUARY

RECENT DEATHS

Dr. James Morford Taylor, professor emeritus at Colgate University, where he held a professorship of mathematics from 1873 to 1920, died on July 31 at the age of eighty-six years.

Dr. Henry W. Henshaw, formerly chief of the U. S. Biological Survey, died at Washington on August 1 at the age of eighty years.

Professor Allvar Gullstrand, professor of physiological optics at the University of Upsala, who received the Nobel prize for medicine in 1911, died on July 27. He was sixty-eight years old.

Glenn H. Curtiss, the widely known aviation pioneer, died on July 23.

The death at the age of sixty-three years is reported of Dr. Wyatt William Randall, chief of the bureau of chemistry of the Maryland Department of Health and associate in chemistry in the School of Hygiene and Public Health of the Johns Hopkins University.

Dr. Arthur A. Law, one of the founders of the American College of Surgeons and for many years a professor in the department of surgery of the University of Minnesota, died on July 9 at the age of fifty-eight years.

Dr. Charles Channing Allen, dean emeritus of the Kansas City Western Dental College, died on July 15.

William Henry Bristol, president of the Bristol Company at Waterbury, Connecticut, known as the manufacturer of recording instruments and as the inventor of the Bristolphone, an instrument which synchronized sound and action in motion pictures, died in June at the age of seventy-one years.

MEMORIALS

A dispatch from Oslo reports that a ceremony took place recently at the monument of Niels Henrik Abel, the great mathematician, when the Italian mathematicians paid him homage through Dr. Bruno de Mori. The Italian legation, the University of Oslo, Norwegian mathematicians and the government were represented.

A meeting in honor of the late Dr. Fridtjof Nansen held on July 14 at the Royal Society of Arts was addressed by Lord Cecil, Mr. P. N. Baker, Mr. Cunninghame Graham, the Norwegian minister and others. The chair was taken by Mr. J. Howard Whitehouse, chairman of the committee for the preservation of the *Fram*.

The *Journal* of the American Medical Association states that "fellows and friends of the London School of Tropical Medicine have subscribed more than £6,000 toward the establishment of a memorial home for the school which Sir Patrick Manson founded and where he taught for twenty years. To further this tribute to the father of modern tropical medicine, the fellows have sent out a general appeal for £20,000 in the belief that many individuals outside of the small professional circle of tropical medicine will help. Donations may be sent to Dr. George Carmichael Low, the Royal Society of Tropical Medicine and Hygiene, 11 Chandos Street, Cavendish Square, London, W. 1."

SCIENTIFIC EVENTS

SCIENCE SERVICE RADIO TALKS

Through the courtesy of the Columbia Broadcasting System in placing a weekly fifteen-minute period at its disposal, Science Service has been presenting a radio talk by a prominent scientist every Friday afternoon at 3:45 p.m., Eastern Time. These began on Friday, March 28, with a talk by Dr. Warren S. Thompson, director of the Scripps Foundation for Research in Population Problems, on "Our Future Population." They are presented through a network of thirty to forty broadcasting stations covering the country from coast to coast.

Other speakers in the series to date have been: Dr. Paul Heyl, U. S. Bureau of Standards; Dean Edward W. Berry, the Johns Hopkins University; Dr. Charles G. Abbot, secretary, Smithsonian Institution; Dr. Harlan T. Stetson, director, Perkins Observatory, Ohio Wesleyan University; Dr. Ray Lyman Wilbur, president of Stanford University and Secretary of the Interior; Dr. Walter V. Bingham, director, Personnel Research Federation; Dr. John C. Merriam, president, Carnegie Institution of Washington; Sir William Bragg, director, Royal Institution of Great Britain; Dr. A. C. Lane, professor of geology, Tufts College; Dr. Fay-Cooper Cole, professor of anthropology, University of Chicago; Dr. Kirtley F. Mather, chairman, department of geology and geography, Harvard University; Dr. Frank E. Lutz, curator of entomology, American Museum of Natural History; Mr. H. N. Eaton, physicist, U. S. Bureau of Standards; Dr. Samuel A. Mitchell, director, Leander McCormick Observatory, University of Virginia, and Dr. Knight Dunlap, professor of experimental psychology, the Johns Hopkins University. All the talks are arranged by Mr. James Stokley, of the editorial staff of Science Service, under the general direction of Watson Davis.

For the months of August and September, Science Service has announced the following program.

August 1. Dr. Charles P. Olivier, director of the Flower Observatory of the University of Pennsylvania—"The August Meteors."

August 8. Dr. W. J. Humphreys, professor of meteorological physics, U. S. Weather Bureau—"Weather and Aviation."

August 15. Mr. H. N. Wheeler, U. S. Forest Service—"Fighting Forest Fires."

August 22. Dr. John M. Arthur, Boyce Thompson

Institute for Plant Research—"Light and Green Plants."

August 29. Dr. William A. White, Superintendent, St. Elizabeth's Hospital—"Mental Hygiene."

September 5. Mr. Charles L. Mitchell, principal meteorologist and district forecaster, U. S. Weather Bureau—"Tropical Hurricanes."

September 12. Mr. Watson Davis, managing editor, Science Service, Inc.—"Industrial Revolutions."

September 19. Dr. A. F. Blakeslee, assistant director, Station for Experimental Evolution of the Carnegie Institution of Washington—"Heredity and Environment."

September 26. Dr. Paul G. Redington, chief, Bureau of Biological Survey, U. S. Department of Agriculture—"Uncle Sam Watches his Animals."

The talks are given at 3:45 p. m., Eastern Daylight Saving Time, while such time is in effect. After that they will be given at 3:45 p. m., Eastern Standard Time. They are presented from the Columbia studios in New York City, Philadelphia, Washington or Atlantic City.

PLANS OF THE SCRIPPS INSTITUTION FOR COOPERATION WITH EASTERN AGENCIES

COOPERATION by the Scripps Institution of Oceanography of the University of California with several eastern organizations has been arranged by Dr. G. F. McEwen, of the institution staff, who has recently returned from Washington and other cities in the East, according to announcement by Director T. Wayland Vaughan. Dr. McEwen made the trip to the Atlantic coast on business connected with preparation of reports on hydrographic observations made by the Carnegie Institution of Washington on the recent cruise of the non-magnetic ship *Carnegie*, and with the development and extension of the work on marine meteorology and weather forecasting by the Scripps Institution.

In the course of this trip a number of preliminary or provisional plans were discussed for closer cooperation between the Scripps Institution and several eastern organizations already active in related work. At Toronto, Ontario, Director J. Patterson, of the Canadian Meteorological Service, agreed to tentative plans for giving the Scripps Institution the use of thermograph records being obtained by four Canadian Pacific liners in regular service across the North Pacific. Each of these ships has a thermograph giving a continuous record of condenser-intake temperatures encountered from port to port.

At Clark University Dr. McEwen had a conference with Dr. C. F. Brooks, meteorologist, in which possibilities of cooperation in use of records and observations was discussed. At the office of the United States Weather Bureau in Washington arrangements with Mr. F. G. Tingley were practically completed, whereby copies of sea surface temperatures, winds and barometric pressures taken by ships will be made from the Scripps Institution to use in its work of forecasting rainfall in California. Similar arrangements were made with Mr. A. B. McManus in charge of the hydrographic records of the hydrographic office of the United States navy, by which copies of records of sea surface temperatures and of wind movements will be available for use by the Scripps Institution in its work of forecasting.

THE FOURTH GREENLAND EXPEDITION OF THE UNIVERSITY OF MICHIGAN

LARGELY as a result of the recently announced plans of the British Arctic Air Route Expedition, which is to be based on Angmagssalik in East Greenland, the plans of the Fourth Greenland Expedition of the University of Michigan have been somewhat modified.

The "eastern" party under Carlson instead of basing on Angmagssalik will be located near Upernivik in northwest Greenland. This party consisting of William S. Carlson and his assistant, Max Demorest, sailed July 31 on the Canadian Government steamship *Beothic* from North Sydney, Nova Scotia, direct to Godhavn in North Greenland, from which point it will later proceed to Upernivik on the Danish motorship *Disko*.

This party has material for construction of a house and is provisioned for one year's stay. It is equipped for carrying out upper-air studies, and pilot balloons will be sent up on all fair days for study of the atmospheric circulation. The front of the Cornell Glacier, one hundred and twenty-five miles north of Upernivik, which was surveyed by Tarr's Cornell Expedition more than thirty years ago, will be re-surveyed by Carlson. Dog sled expeditions over the inland-ice will be made by Carlson and special glacial studies carried out.

Evans S. Schmeling, conducting the southern party, will, as already stated, sail from Philadelphia for Ivigtut in extreme south Greenland August 13 on the ore freighter *Wagland* chartered by the Pennsylvania Salt Manufacturing Company of Philadelphia. Schmeling will carry out similar upper-air and glacial observations to those at the north station. The little settlements of Upernivik and Ivigtut are, respectively, about four hundred and fifty miles north and four hundred and fifty miles south of the Mount

Evans Station, the base of the second and third expeditions of the university.

The first volume of the technical reports on the earlier expeditions, which is devoted to aerology and edited by S. P. Fergusson, of the U. S. Weather Bureau, is now complete and ready for printing.

THE INTERNATIONAL CONFERENCE OF AGRICULTURAL ECONOMISTS

DELEGATES to the International Conference of Agricultural Economists will meet at Cornell University from August 18 to 29. Delegates from England, Ireland, Australia, Germany, Poland, Finland, Russia and other European countries and from China and Japan arrived in New York on July 27, spending four days in an inspection and sight-seeing tour of the city. Delegates to the conference from abroad include:

George Dallas, M. P., London, England; Miss Persia Campbell, Melbourne, Australia; Kuro Koboyokawa, Tokio, Japan; A. Bridges, Oxford; O. Vopelius, University of Berlin; B. Duncan, Scottish Farm Servants' Union, Sterling; T. Whittaker, University of Edinburgh; Price Howell, Aberystwith; D. E. Harkness, Minister of Agriculture, Belfast; K. T. Jutila, University of Helsingsfors; J. E. Latimer, McDonald College, Quebec; A. Jones, Minton Agricultural College, Sutton Bonington, England; E. Thomas, University of Reading; D. H. Dinsdale, Armstrong College, Newcastle-on-Tyne; C. B. Daw, University of Bristol; F. J. Pruitt, University College, Aberystwith.

F. M. Secay, University of the Philippines, Los Banos; W. Allen, University of Saskatchewan; R. W. Enfield, assistant secretary of agriculture, London; E. M. H. Lloyd, Empire Marketing Board, London; F. E. Geldenhuys, assistant secretary of agriculture, Pretoria; S. Schmidt, University of Cracow, Poland; R. M. Campbell, University of New Zealand; A. Schmindler, Berlin; E. Jensen, Copenhagen; L. K. Elmhurst, Totnes, England; A. W. Ashley, Aberystwith; M. Sering, University of Berlin.

A. N. Duckham, Aberdeen; J. J. W. Seedorf, Göttingen; H. Zoerner, University of Berlin; K. Brandt, University of Berlin; H. von Dietze, University of Jena; L. Feisch, Berlin; A. G. Ruston, University of Leeds; J. King, Edinburgh; Paul Hsu, University of Nanking; J. P. Maxton, Oxford; G. M. Dykes, London; A. A. Buotinkov, Ukranian Agricultural College, Kharkiv, Ukraine; Professors Vavilov, Anisimov, Geister, Goerdieff, Moscow Agricultural Academy.

THE BRITISH MEDICAL ASSOCIATION

THE annual meeting of the British Medical Association this year is to be held in two parts. The first, the annual representative meeting, which discussed policy and internal business, was held in the Great Hall of the British Medical Association House, London, from July 18 to 22, inclusive. The second, the scientific and social part, will be held at Winnipeg from August 25 to 29, inclusive.

The annual representative meeting was presided over by its chairman, Dr. C. O. Hawthorne, of London. According to the London *Times* on the first day there was a discussion on a recommendation of the council of the association "that the time is now ripe for the medical profession to ask for the inclusion under the National Health Insurance Service of the dependents of insured persons."

Under the head of "Medical Ethics" the question of whether a medical practitioner who makes an invention or discovery in the medical field should derive financial benefit from a patent or from royalties was discussed.

Another discussion was under the recommendation of the council that where advice on birth control is given at any maternity or child welfare center, it should be given on medical grounds only, and at the discretion of the medical officer, and not merely because it is asked for by the patient.

On July 19 there was a discussion on the hospital policy of the association, a matter of considerable complexity, having regard to the new position caused by the taking over of the old Poor Law hospitals by the county and county borough councils and the increasing number of contributory schemes throughout the country. This was followed by a discussion on the general medical service proposals of the council, which are in the nature of a contribution to the discussion whether the medical service of Great Britain shall develop as a service, becoming more and more officialized, or as one which, while making available everything medical that any member of the community requires, shall retain so far as possible the independence of the medical profession and the right of the patient to choose his or her own doctor.

The formal annual general meeting was held on July 22, when the president (Professor A. H. Burgess, F.R.C.S., of Manchester) gave place to the incoming president. Professor Harvey Smith, of Winnipeg, was not present, but the president-elect for 1931, Dr. W. G. Willoughby, medical officer of health for Eastbourne, was introduced.

That part of the annual meeting which follows at Winnipeg is divided into 14 sections, of which all the presidents are as follows:

Medicine, Lord Dawson of Penn; Surgery, Lord Moynihan of Leeds; Obstetrics and Gynecology, Mr. Comyns Berkeley (London); Bacteriology, Pathology, Physiology and Bio-Chemistry, Professor Robert Muir (Glasgow); Diseases of Children, Dr. Robert Hutchison (London); Mental Diseases and Neurology, Sir Farquhar Buzzard, Bt. (Oxford); Ophthalmology, Mr. N.

Bishop Harman (London); Laryngology and Otology, Sir St. Clair Thomson (London); Preventive Medicine, Dr. A. S. M. Macgregor (Glasgow); Tuberculosis, Professor A. Lyle Cummins (Cardiff); Radiology, Dr. A. E. Barclay (Cambridge); Medical Sociology and History of Medicine, Dr. J. D. Comrie (Edinburgh); Anesthesia, Dr. R. E. Apperly (London); Orthopedics, Mr. Laming Evans (London).

SCIENTIFIC NOTES AND NEWS

DR. F. O. BOWER, emeritus professor of botany at the University of Glasgow, who succeeds Sir Thomas Holland as president of the British Association for the Advancement of Science, has taken as the subject of his address "Size and Form in Plants." The meeting of the association is at Bristol from September 3 to 10.

PROFESSOR PAOLO ENRIQUES, director of the institute of zoology, comparative anatomy and physiology in the University of Padua, will preside over the International Zoological Congress which will hold its eleventh session in Padua from September 4 to 11.

THE Lister Memorial Lecture before the Royal College of Surgeons of England was delivered by Dr. Harvey Cushing, professor of surgery, Harvard Medical School, on July 9 on "Neuro-hypophysial Mechanisms from a Clinical Standpoint." On this occasion the Lister Medal was presented to Dr. Cushing.

PROFESSOR MARTIN HAHN, director of the National Hygiene Institute of Berlin, was elected president of the International Association of Microbiology at the recent meeting in Paris. Sir Almroth Wright was elected honorary president. Among Americans attending the congress were Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, and Dr. William Hallock Park, director of the New York Health Department Bureau of Laboratories.

DR. LEONHARD STEJNEGER, head curator of biology at the National Museum, and Dr. Charles W. Stiles, chief of the division of zoology of the Public Health Service and custodian of the helminthological collections of the U. S. National Museum, have been appointed delegates from the United States Government to the eleventh International Congress of Zoology to be held in Padua next month.

AT a recent election of the American Institute of Electrical Engineers, William S. Lee, consulting engineer, Charlotte, N. C., was made president of the institute for the year, beginning August 1. Other officers elected were: *Vice-presidents,* I. E. Moultrop, Boston, and H. P. Charlesworth, New York; T. N. Lacy, Detroit; G. C. Shaad, Lawrence, Kansas, and H. V. Carpenter, Pullman, Washington; *Directors,* A. B. Cooper, Toronto, Ont.; A. E. Knowlton, New York, and R. H. Tapscott, New York; *Treasurer,* George A. Hamilton, Elizabeth, N. J. (reelected).

NEW officers elected at the recent meeting of the American Society of Clinical Pathologists are: *President,* Dr. Kenneth M. Lynch, Charleston, South Carolina; *President-elect,* Dr. H. J. Corper, Denver, Colorado; *Vice-president,* Dr. Clarence I. Owen, Detroit, Michigan, and *Secretary-treasurer,* Dr. A. S. Giordano, South Bend, Indiana.

AT the recent meeting in Detroit of the American Medical Association gold medals were awarded to Professors Frederick G. Novy and Malcolm H. Soule, of the University of Michigan, for "excellence of presentation of studies on respiration and dissociation of micro-organisms."

PROFESSOR HOWARD E. SIMPSON, of the department of geology of the University of North Dakota and state water geologist, received the honorary degree of doctor of science at the commencement exercises of Cornell College, Mount Vernon, Iowa, his Alma Mater.

DR. KURT HERBST, professor of experimental embryology at the University of Heidelberg, and Dr. Kasimir Fajans, professor of physical chemistry at the University of Munich, have been elected members of the Polish Academy of Sciences at Krakau.

THE Messel Medal, awarded for services to the chemical industry, was presented to Lord Brotherton on July 18 at the forty-ninth annual meeting of the Society of Chemical Industry at Birmingham. The late Lord Balfour and the late Lord Leverhulme were previous recipients of the medal. In making the presentation, the retiring president, Dr. Herbert Levinstein, said it was the fashion now-a-days, in some circles, to consider it a crime for a man to be successful in industry. "We do not share that view," he added. "We are bestowing this medal upon Lord Brotherton chiefly because from small beginnings, by enterprise, by courage, by great industry and by the force of his personality he has built up one of the most successful chemical industries in the country." After acknowledging the presentation, Lord Brotherton delivered the fifth Messel Lecture, entitled "Fifty Years in the Chemical Industry."

THE council of the University of Manchester has

unanimously adopted a resolution paying tribute to the work of Professor F. E. Weiss, on the occasion of his retirement from the George Harrison chair of botany, which he has held since 1892, expressing their gratitude to him "for the outstanding services which he has rendered to the university."

The title of emeritus professor of physics in the University of London has been conferred on Professor C. H. Lees on his retirement from East London College.

At the Ohio State University the following appointments have been made in the department of physics: Professor Alfred Landé, of the University of Tübingen, professor of theoretical physics; Dr. L. H. Thomas, of Trinity College, associate professor of theoretical physics, and Dr. H. H. Nielsen and Dr. W. H. Bennett, instructors in physics.

Dr. George T. Hargitt, professor of zoology at Syracuse University, has been appointed graduate professor of zoology at Duke University.

Dr. John Rennie has been appointed professor of public health in the University of Sheffield in place of the late Professor F. E. Wynne. Dr. Rennie is medical officer of the City of Sheffield.

Dr. P. W. Gregory, of Baker University, has joined the staff of the University of California at the Davis Branch of the College of Agriculture as geneticist in the division of animal husbandry.

John A. C. Warner, of the Studebaker Corporation, has been appointed secretary and general manager of the Society of Automotive Engineers to succeed the late Coker F. Clarkson, the only previous incumbent of the position, who had held it for the past twenty years.

Perry A. Davison, George F. Taylor, William S. Pike, Jr., and Charles F. Park, Jr., have been appointed junior geologists in the U. S. Geological Survey.

Dr. J. L. Byrd, formerly health officer of Colon, has been appointed health officer of Panama City, to fill the vacancy caused by the death of the late Dr. Paul Preble.

Dr. Robert Cunningham Miller, of the University of Washington, visiting professor of biology in Lingnan University, Canton, China, is conducting a survey of the marine wood-boring organisms of the coast of China. The project is being financed jointly by Lingnan University and the Rockefeller Foundation. The cooperation has been secured of the Chinese Maritime Customs.

Dr. R. J. Lang, associate professor of physics in the University of Alberta, at Edmonton, Canada, will spend next year in research work at the Physical "Reichsanstalt," Berlin.

Professor William B. Herms, professor of parasitology at the University of California, gave an illustrated lecture at the Franz Theodore Stone Laboratory of the Ohio State University, at Gibraltar Island, Put-in-Bay, Ohio, on the evening of July 25. His lecture dealt mainly with the fauna and flora of certain typical coral atolls of the Mid-Pacific Ocean. Professor Herms is a visiting professor at the Ohio State University during the summer quarter.

The Association of American State Geologists, composed of chief geologists in forty-one states, will hold its annual field conference in Wyoming and Montana from August 24 to 29, according to a statement issued by the Wyoming State Geologist, John G. Marzel. The conference will assemble in Glacier National Park and thence proceed to Butte, at which mining center the annual business sessions will be held on August 25 and 26. Following this a tour will be made of Yellowstone Park.

The opening of the International Electro-Technical Congress took place in Copenhagen, although the various conferences are to be held in Stockholm. This was due to many of the delegates desiring to honor Hans Christian Orsted, formerly professor of natural philosophy in the University of Copenhagen, known for his researches in electromagnetism. Visitors from Austria, Germany, Belgium, Brazil, Canada, France, the United States, Holland, England, Norway, Poland, Switzerland, Greece, India, Japan, Rumania, Czechoslovakia and Soviet Russia visited Orsted's statue, and were entertained in Copenhagen.

Mr. George Eastman has given $1,000,000 to the Italian Government for the erection of a clinic and college in Rome.

According to the German press the Rockefeller Foundation has given $375,000 for a new building for the research division of the zoological institute of the University of Munich under the directorship of Professor Dr. K. von Frisch, and for the institute of physical chemistry under the directorship of Professor Dr. Kasimir Fajans. A grant of $675,000 is said to have been made from the foundation for the Kaiser Wilhelm Society in Berlin, which since its foundation in 1911 has grouped round it a dozen institutes for the promotion of science. The grant is especially made for the purpose of providing Professor Max von Laue and Professor Otto Warburg with institutes for their work.

The Max Pam Metabolic Unit for Clinical Research in diseases of metabolism was opened on July 21 at the Michael Reese Hospital, Chicago. A capital fund

of $150,000 is provided for the maintenance of this unit, which is equipped for the investigation of metabolic diseases along physiological and chemical lines. It will be conducted in cooperation with departments of the Nelson Morris Institute of Research, which is a part of the Michael Reese group.

MR. EDO NICOLAUS CLAASEN, of Cleveland, has given his private collection of ten thousand botanical specimens to the department of biology of Western Reserve University.

MR. H. EARLE RUSSELL, United States Consul, Alexandria, Egypt, reports to the *U. S. Daily* that the Egyptian ministry of agriculture has decided to create at Cairo an agricultural museum, costing about $1,000,000, and to invite the director of the Budapest Agricultural Museum to go to Egypt to undertake the organization of the museum. The Egyptian Royal Agricultural Society has decided to hold a general agricultural and industrial exhibition on its grounds at Ghezireh, near Cairo, in February, 1931. The society has requested the Egyptian premier that it may receive assistance from all the government departments that aided in the 1926 exhibition. These included the participation of the ministry of agriculture, the state domains, the survey administration and the schools of the ministry of education; the ministry of communications which reduced by 70 per cent. the fares of passengers going to Cairo for the exhibition and the freight rates on livestock and articles for exhibition purposes, and the administration of posts, telegraphs and telephones, which set up offices inside the exhibition grounds. They also included the department of commerce and industry which encouraged industrial establishments to take part; the prisons administration, which exhibited the works of prisoners; the governors and mudirs, who made propaganda in their respective provinces; the ministry of public works which helped in the construction of buildings, roads and gardens for the exposition, and the frontiers administration which organized a special section showing the habits of the bedouins and their modes of life.

THE thirty-ninth annual report of the council of the British Institution of Mining and Metallurgy records, as reported in *Nature*, the following awards which were presented at the annual general meeting on June 26. The gold medal of the institution to Sir Thomas H. Holland, in recognition of his distinguished services to geological science and to the mineral industries during his tenure of high public appointments—notably those of director of the Geological Survey of India and of rector of the Imperial College of Science and Technology—and of his researches and publications upon the mineral resources of the British Empire and their relationship to national and international problems. "The Consolidated Gold Fields of South Africa, Ltd." premium of forty guineas to J. B. Richardson, for his paper on "The Importance of Recovered or 'Secondary' Tin." The "William Frecheville" Student's Prize of ten guineas to A. Bray, for his "Notes on the Banket Reefs of the Gold Coast Colony." The "Arthur S. Dwight" post-graduate traveling grant of two hundred guineas to W. D. Jones. In accordance with the conditions of the grant, Mr. Jones proceeded to the United States last October, where he spent about three months in the study of metallurgical plants and in making personal contacts with operating men. Since his return to England he has submitted to the council an exhaustive report of his visit. A special grant of £50 from the "Post-Graduate Grants Fund" of the institution to S. R. B. Cooke, to enable him to proceed to British Columbia to gain practical experience. The grant was made on the nomination of Professor James Park, dean of the faculty of mining and economic geology of the University of Otago, New Zealand.

A REPORT issued by the trustees of the British Museum describes the progress during 1929 both of the collection at Bloomsbury and of the Natural History branch of the British Museum at South Kensington. The director and principal librarian of the British Museum, Sir Frederic Kenyon, records a rise in the general attendance of visitors at the museum of over 10,000 compared with the previous year. The figures are 1,191,758 for 1929, and 1,181,617 for 1928. He attributes the greater part of this increase to the longer hours of opening on Sunday afternoons, which came into force in October, 1928. The month of August, 1929, with a total of 161,697 visitors, showed the highest monthly total on record, and in general the attendances in the second half of the year exceeded those in the earlier months. The number of visitors to the reading room fell off by rather more than 1,000 from the high total of 1928, the figure for 1929 being 214,375, an average of 707 daily. Visits of students to particular departments fell off from 276,890 to 272,352. Dr. C. Tate Regan, the director of the Natural History Museum, notes a general decrease in the number of visitors to South Kensington from 567,273 in 1928 to 541,198 in 1929. The Sunday afternoon attendances have decreased by less than 500, and the lectures of the official guide were attended by 12,972 persons, as against 13,826 for the previous year. The museum building is being extended and the new Spirit Building, designed at present for the use of the department of entomology, almost completed.

DISCUSSION

THE RELATION BETWEEN A NEGLECTED CLASS OF FACTS AND THE UNIVERSAL LAW OF ORGANIC EVOLUTION

The importance to science of the dates of specific names is recognized. No stable nomenclature is attainable, even in a remote future, if they be disregarded. But to dates of first collection of species no such obvious weight attaches. Great as is the improvement in this respect, it is not yet by any means the universal practice to include even the date of collection of the type in the description of new forms. A generation or two ago such dates were commonly omitted, and to determine the dates of collection of specimens older than the type then or now is a matter of no little difficulty.

Yet dates of first collection are basic biological facts. They depend very definitely upon the location and extent of specific ranges. And, biologically speaking, where species are is second only in importance to what they are. In fact, they are where they are, because they are what they are.

These dates of first collection permit comparisons of various kinds to be made with respect to the time-order of discovery of known species; and from such comparisons interesting results, of which the following are an earnest, may be anticipated.

Investigation shows that in the Chiroptera, for example, the species of smaller genera make up a smaller proportion of the first than of the second half of the known total to be discovered. Or putting this generalization in other words, species of the larger genera are discovered more often early than late; of the smaller genera, more often late than early.

It is a perfectly natural conclusion that this inverse relation depends upon peculiarities in the distribution of species of the two sorts of genera, but this is at present somewhat beside the point. The main fact is that the species of to-day's small genera make up a larger proportion of the total known species of bats than they did in the early collections. By extension of the reasoning it is to be inferred that of the actual small genera in the world—those that will be the small genera at last when the census of species is complete—will form as that time approaches a larger and larger proportion of the known total.

Under these circumstances it is clear that the curve of genera plotted by size will change as time passes, and change in a predictable way.

This raises an old problem in new form.

Biologists must ask themselves now, not why the curves of genera plotted to species should be essentially uniform for the different natural groups of plants and animals, as Dr. J. C. Willis discovered them to be. Instead, they must ask why these curves, now alike, are changing in the same direction, and apparently approaching the same limit.

Dr. Willis's discovery means that there is one law of evolution manifest upon the same terms in all natural groups of organisms. For if in different groups the proportionate number of genera of different sizes is constant, genera are multiplied and with the passage of time increase in size according to one system, and one only.

What this system may be is, of course, not to be discovered through analysis of empirical curves of genera plotted to species, but through study of the limiting form toward which they are moving.

Under the circumstances it quickens the imagination to discover that this limiting curve is at least very close to, if not identical with, a definite mathematical function of the curve of normal frequency. As a matter of fact, there is independent and apparently conclusive reason for believing that precisely this function of the normal curve is the ideal to which the curve of genera plotted to species should conform.

The equation of the ideal may be written in terms of the constants and variables of the normal curve. This equation gives the law of evolution as concise and accurate expression as is possible. It was stated, not altogether correctly, in more familiar terms in an earlier issue of Science.[1] In corrected form it appears in the *Anatomical Record*.[2]

W. H. Longley
Goucher College

THERE IS NO CONTROL

A word is needed to mean definitely the things we can do to avoid injury from pests affecting crops. The writer was one of those who early adopted the word control with the hope that this word when applied to insect pests would come to mean precisely that. Every one will admit that this is the chief meaning at present, but *there is no control of language* because there are just enough people who insist on stretching it to cover other meanings to leave it uncertain.

Let us suppose the case of a farmer writing to me concerning a certain pest and asking how it is con-

[1] W. H. Longley, "A Note upon the Probable Mode of Evolution," Science, 69: 462–465, May 3, 1929.
[2] 44: 241, 1929.

trolled. I might answer, "My dear fellow, the pest is already controlled by lethal factors and fluctuations of food supply, the cold, heat, winds and storms control it as do natural barriers, such as rivers, etc., and besides certain birds and beetles control it. Likewise, a fly parasite and a parasite wasp. Unfortunately, the latter is also controlled by a hyperparasite." In reply, supposing his anger was controlled by various inhibitions, including an inferiority complex, he might say, "Excuse me that I did not use the right word, but I am an unlearned and ignorant man. The insect has now controlled the crop and it is all dead."

I want to protest again and as strongly as I know how against the above uses of the word for meanings for which there are so many more precise designations and to urge that these other words be used, such as natural checks, climatic restrictions, topographical barriers, biological limitations or even environmental resistance for all these things that have no direct practical bearing on the problems of the farmer. He is thinking of the things that he can do to avoid the losses due to insects, fungi and other troubles. Control in this usual sense applies correctly in such cases as frost control which is accomplished by orchard heating and to moisture control by means of irrigation and cultivation. It would be just as bad to confuse these practices with meteorological limitations, restrictions or barriers. Our cooperative associations are beginning to accomplish very effectively the control of marketing to avoid this class of losses. In this work one also meets with commercial limitations, checks and barriers that must be considered, but must not be confused with what we can do to obtain better prices.

Those who insist on using the word control to express also other ideas should at least suggest another word that could be exclusively used to mean precisely what the great majority do mean when they say control.

C. W. WOODWORTH

BERKELEY, CALIFORNIA

BLACK WALNUT CANKER

IN the fall of 1929, the extension specialist in forestry at West Virginia University, Mr. T. W. Skuce, informed me of the occurrence in the north central part of this state of a serious canker on the black walnut, *Juglans nigra* L. It was not until February, 1930, that I was able to obtain specimens in the field.

This disease has been observed upon trees varying in diameter from three to twenty inches. The cankers are located at any point on the older wood but are most conspicuous upon the trunk and larger branches where they form "cat-faces" or targets composed of very prominent concentric rings of callus tissue. The margins of the cankers are very rough, being composed of the last formed and largest roll of callus tissue, together with the attached bark. This gives the characteristic cankers a concentric flaring appearance with a diameter which is usually greater than the diameter of the trunk or limb at the point of canker formation. What appear to be young infections often show a burl-like growth before they open up to form the concentric rings so typical of the older cankers.

It has been noted also that whenever a tree is attacked several cankers are present and are well distributed on the trunk and larger limbs. Other trees near by may show no symptoms of disease. This is suggestive of an inherent difference in susceptibility among trees of similar ages in the same stand.

On many of the cankers, most commonly on the callus rings of two or three years ago, the perithecia of a Nectria are abundantly formed.

The appearance of this Nectria associated with such characteristic cankers suggests that this disease is closely related to the European canker which is well known in Europe on beech and other deciduous trees, and in America on the cultivated apple, but not reported as occurring upon black walnut. In fact, there are no published records so far as I can ascertain of this disease of the black walnut.

Because of the commercial importance of the black walnut in West Virginia and the fact that this disease renders the timber practically worthless, arrangements have been made by the Agricultural Experiment Station of West Virginia to conduct an investigation of this disease, including its geographical distribution, its origin, nature, host range, importance and the conditions surrounding infection and spread by the pathogen. This note is published to call attention to the black walnut canker; any information regarding its occurrence anywhere will be gratefully received.

C. R. ORTON

WEST VIRGINIA UNIVERSITY

DUTCH ELM DISEASE IN OHIO

SEVERAL cases of the Dutch elm disease have been found in Ohio. The field symptoms exhibited were similar to those of the Dutch elm disease. The leaves wilted on certain branches or over the entire tree. Later, they turned yellow and dropped. The affected limbs died. When cross sections were made the typical brown discoloration of the vascular tissue was found, appearing generally as a broken ring but sometimes forming a complete circle. When the bark

was peeled back the stains appeared as short brown streaks in the spring wood.

The fungus which grew from the plantings of small pieces of the discolored wood on acidified potato dextrose agar produced a grayish white rather sparse and appressed mycelium showing zonation. Some of the colonies were yeast-like in appearance. Conidia approximately 1.5 x 3.5 μ were produced in heads on branched conidiophores. Budding of many conidia was observed. Coremia with spores approximately 3.3 x 1.7 μ formed on the wood plantings and on the agar.

A part of the lot of the original specimens sent to the Ohio Agricultural Experiment Station were forwarded to Dr. Christine Buisman, of Holland, at present at the Arnold Arboretum. She also isolated *Graphium ulmi* Schwarz from the diseased twigs.

The cases observed in Ohio have shown marked evidence of parasitism. The disease has been very destructive in Europe, and we should know as quickly as possible how wide-spread the disease is here. Specimens sent to the writer will be appreciated and will receive prompt attention.

CURTIS MAY

OHIO AGRICULTURAL
EXPERIMENT STATION,
WOOSTER

THE PHOTOTROPY OF ULTRA-VIOLET-TRANSMITTING GLASSES

Two years ago when the Boyce Thompson Institute entertained the local sections of the American Chemical Society, I noticed that a sheet of ultra-violet-transmitting glass, said to be Corex, which had been used in a hot bed frame and exposed to a quartz mercury lamp, showed a distinct pinkish brown tinge. A more striking observation was that a piece of the same glass, exposed also to a mercury lamp and in addition to sunlight, showed no coloration whatever and had remained perfectly colorless.

This observation suggested that Corex was phototropic, and that the longer wave-length light supplied by the sun tended to reverse the colorizing action of the mercury lamp.

This supposition has been confirmed by more recent observations. Wood and Leathwood[1] determined quantitatively that ultra-violet-transmitting glasses which had been colored by exposure to a mercury lamp were completely restored to their original transparency by exposure to sunlight. Shrum, Patten and Smith[2] and Nitchie and Schmutz[3] have shown that the color produced by mercury lamp solarization can be completely destroyed by heating the colored glass. Clearly, then, the colorizing action of short wave-length light is reversed by longer wave-length light, and by heat. That is, the phenomenon is one of phototropy.

The purpose of this note is to draw attention to the striking similarity between the behavior of ultra-violet-transmitting glasses and the more extensively studied though little known phenomenon of phototropy. It is thought that the history of lithopone and other phototropic substances[4] may be useful to those who have occasion to handle these new glasses and who may wish to control the solarization effects either in manufacture or in use.

LYMAN CHALKLEY, JR.

NEW YORK

[1] Wood and Leathwood, *Nature*, 124: 441, 1929.

[2] Shrum, Patten and Smith, *Transactions Roy. Soc. Canada* (3), 22: 433, 1928.

[3] Nitchie and Schmutz, SCIENCE, 71: 590, 1930.

[4] For a bibliography see *Chemical Reviews*, 6: 217, 1929.

THE RATE OF WORK DONE BY A RICKSHA-COOLIE

PROFESSOR BASLER'S article in the May 3, 1929, issue of SCIENCE on "Rate of Work Done by a Ricksha-Coolie," in which he finds one tenth horse-power as his work expended for short periods of time, is interesting. For comparison with his result, I present the following computation of the rate of work done by a man in walking (climbing) in the White Mountains, in going from the Ravine House in Randolph, New Hampshire, to the summit of Mt. Washington, by way of the Randolph path and the Gulf Side trail, a distance of nine and one half horizontal miles. The altitude of the Ravine House is 1,280 feet and of the summit of Mt. Washington 6,290 feet, thus giving a gain of 5,010 feet in making the ascent. To this should be added 270 feet as an allowance for two notable dips in the trail. This gives a total gain in elevation of 5,280 feet.

The trip can be made under favorable weather conditions in four hours. This would correspond to an average gain in elevation of 22 feet per minute. In the case of a man whose weight is 150 pounds, the power developed in merely raising his weight would be 3,300 foot pounds per minute, or exactly one tenth of a horse-power.

As in the case of the coolie, the man has also to expend energy in traveling the horizontal distance, and, of course, in overcoming numerous slight obstacles on the uneven path of the mountains. A sustained average of one tenth horse-power for a period of four hours would appear to be a creditable performance as measured by the figures reported by Professor Basler.

ALVAN L. DAVIS

SPECIAL CORRESPONDENCE

FIELD WORK OF THE NATIONAL MUSEUM OF CANADA, 1930

THE National Museum of Canada, in continuance of a fixed policy of conducting investigations among the aboriginal inhabitants of the country and of making zoological and botanical surveys, will have ten parties in the field during the summer of 1930. The National Museum profits also from the field work of the Geological Survey. Between the two institutions there is the closest cooperation, and the mineralogical and geological sections of the museum are assembled and maintained by the Geological Survey.

In the realm of anthropology efforts are being made to conduct vigorous research among the Indians with a view to obtaining information from the older people regarding the customs and culture of the race uninfluenced as far as possible by contact with the whites. The longer this work is delayed the less satisfactory are the results, as Indians have shown a great readiness to adopt from European civilization anything that will serve their needs. C. M. Barbeau, who has made extensive observations on colonial influences on the Indians of eastern Canada, will continue this summer his work in certain parts of Quebec, Ontario and New York, studying modern handicrafts and designs used by the Indians and concentrating on bag-making, basket-making, wood-carving and quill and moose-hair work with a view to getting a better comprehension of the original native art and culture.

An ethnological study of the Indians living around Lake Abitibi will be undertaken by J. T. MacPherson. This will include an investigation into the economic life of the Indians in earlier times, their original material culture, their social organization and the presence or absence of totemic clans, shamanism and its connection with the puberty fast, and their religious beliefs.

The summer will be spent by I. A. Lopatin among the Indians living around Kitimat, British Columbia, and an investigation will be made of their social and religious life, special attention being given to the phratric, clan and family systems with their crests and privileges, to their government, the institution of property and the potlatch system, social customs, religious beliefs and practices including secret societies and their rites and intercourse with neighboring peoples.

Dr. J. C. B. Grant, of the University of Manitoba, will make among the Cree Indians of Wabasca and of the reserves south of Lesser Slave Lake, Alberta, a complete series of physical measurements of adults and children. This is in continuation of the anthropometric investigations that Dr. Grant has been conducting among the Indians of the western interior of Canada.

Archeological excavations will be made near Newcastle, New Brunswick, and on the Magdalen Islands, Quebec, by W. J. Wintemberg. It is hoped that some light will be thrown thereby on differences in handicraft between the Micmac Indians of eastern New Brunswick and those of the Nova Scotia coast. Excavations on the Magdalen Islands may reveal a southward extension of Eskimo cultural influence, evidences of which have been detected on the west coast of Newfoundland.

The biological division of the museum will have five parties in the field. Jacques Rousseau will carry on a botanical survey of parts of Nova Scotia and collect flowering plants for the herbarium. This is in connection with the preparation by Dr. M. O. Malte of a comprehensive work on the systematic flora of the Maritime provinces. Dr. H. M. Raup will complete a botanical survey which he has been conducting since 1928 of a part of Wood Buffalo Park west of Slave River.

A study of the mammals of southeastern British Columbia will be continued by H. M. Laing; collections will be made and observations recorded with regard to their distribution and the relation of distribution to variations in topographical features. Collections will also be made in Jasper Park and Rocky Mountain Park. P. A. Taverner will commence this season a thorough ornithological investigation in the vicinity of Churchill on the west coast of Hudson Bay, making observations on the migration of birds and their habitat and making extensive collections for detailed study. Jos. Rochon will spend a part of the season in collecting mammals in the vicinity of Ottawa.

The National Museum is an outgrowth of the Geological Survey and is dependent on it for exhibition material in geology, paleontology and mineralogy. Fine specimens of ores and rocks from leading mining districts are obtained by economic geologists, and invertebrate fossils by stratigraphic paleontologists. It is expected that a good collection of vertebrate fossil material will be obtained this season by C. M. Sternberg from the Peace River block. A. T. McKinnon will collect mineral and rock specimens from different parts of Ontario and Quebec. The greater part of this material will be used in preparing sets for prospectors and for educational institutions, but the choicest specimens will be added to the permanent collection of the museum.

W. H. COLLINS

QUOTATIONS

THE WINNIPEG PROGRAM OF THE BRITISH MEDICAL ASSOCIATION

ON August 22 the Canadian Medical Association begins the business of its sixty-first annual session at Winnipeg, under the presidency of Professor W. Harvey Smith, and three days later members of the British Medical Association from this country and other parts of the Empire assemble in that city, as guests of our Manitoba colleagues, for the ninety-eighth annual meeting of the British Medical Association. On August 26 they will be welcomed by the Prime Minister of Canada and the Mayor of Winnipeg, and Professor Harvey Smith, after installation as our president for 1930–31 at the hands of Professor Burgess, will deliver his inaugural address. The association has only met twice before outside the British Isles, and each time in the Dominion of Canada—at Montreal in 1897 and at Toronto in 1906. On this occasion something more than friendship and common ties will unite visitors and hosts, because since the year 1924 the two professional bodies, by accepting formal affiliation, have come into close organic touch on matters of mutual concern. The Winnipeg meeting of 1930 is thus a landmark in association history. Those who are fortunate enough to take part in it will have done something to strengthen the links between the profession at home and the profession overseas, and to show that the British Medical Association is Empire-wide in its outlook.

The revised program of work for the scientific sections, with a good deal of other information about the arrangements for the meeting, appears in our Supplement this week. Brief particulars of the journey by sea and land, and some useful hints for travellers, are also given, but any member proposing to go to Winnipeg should apply at once to the financial secretary for a copy of the booklet containing full details of the various tours. In general the program for the annual meeting of 1930 follows fairly closely the pattern with which we are familiar on this side of the Atlantic, except that all medico-political business will already have been disposed of at the annual representative meeting which opens on July 19 at the association's headquarters in London. The fourteen sections are to meet on the mornings of August 27, 28 and 29, and a very varied and interesting list of subjects, both clinical and scientific, has been drawn up for consideration. While the number of set debates is larger than usual and several sections will combine to discuss borderline topics, the occasional paper has not been elbowed out altogether, and (as an example of how hard it is to draw a clear-cut line) the subject chosen for the joint meeting of the sections of surgery and tuberculosis is so wide that its "discussion" might almost as well be described as a series of independent papers, each concerned with a different aspect of thoracic surgery.

Some of the social events of the week—they include a skating carnival and an Indian pageant—have a very agreeable air of novelty to English eyes. A break with tradition will be perceived also in the announcement of five clinical addresses to be delivered at special afternoon sessions. When our brethren in Canada travel long distances to take part in a medical congress they mean business, and the chance of hearing an authority from these Islands speak to them on his own subject is in their opinion too good to be missed. They expect some fun, but work comes first. Hence Sir William Wheeler, Dr. H. C. Cameron, Sir Lenthal Cheatle, Professor W. E. Dixon and Sir Farquhar Buzzard (whose subject, perhaps chosen in a spirit of gentle irony, is "Rest, Work and Play") may be sure of large and appreciative audiences in the Winter Club on summer afternoons. For like reasons, we may suppose, Lord Dawson and Dr. Robert Hutchison have been persuaded by the local executive to address a public meeting on the night of August 27; and the week's proceedings will fittingly close with the delivery of Lord Moynihan's Listerian Oration, under the chairmanship of Professor John Stewart of Halifax, a veteran surgeon who was Lister's pupil and friend in Edinburgh and is one of the most admired and respected personalities in the Canadian medical profession.

A very warm welcome awaits every member who visits Canada next month. Those on this side who have been in constant touch with them during the past two years and more know that the president-elect and his immediate local colleagues, Dr. J. D. Adamson, Dr. C. A. Mackenzie and Dr. Ross Mitchell, are determined to make the Winnipeg meeting memorable in the annals of the British Medical Association; and that the Canadian Medical Association, through its general secretary, Dr. T. C. Routley, and its acting-editor, Dr. A. G. Nicholls, is cooperating in the fullest measure. If hard work, enthusiasm and foresight can ensure success, then the ambition of Professor Harvey Smith and company will be realized. Canada is very good at organizing affairs, large or small. Almost the only thing they can not guarantee without our help is an attendance from the British Isles worthy of the occasion and of their efforts.—*British Medical Journal.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE IOWA PIANO CAMERA

THE apparatus here described was developed for the purpose of studying piano playing. It gives an objective photographic record of the duration, time of incidence and time of ending as well as a relative measure of intensity of each note struck for a piano selection under normal conditions of performance.

The record is made on a 4-inch Eastman sensitized paper, passing at the rate of 12.5 centimeters per second. The record consists of a path for each of the keys on the piano keyboard and shows for each key the exact moment at which the hammer strikes the string and the moment of the beginning of the release of the key. It also shows for each note the velocity of the hammer in terms of the time for traversing the last 12 millimeters in the stroke of the hammer. On the same principle, a separate line on the film indicates the movements of the damper pedal. The time is indicated by 25 parallel lines to the second across the width of the entire film.

The record is made of the movement of the hammer by having a very light paper strip, approximately 7 centimeters long and 7 millimeters wide, glued to the tail of each piano hammer. This strip has a narrow slit, 3 millimeters by 7 millimeters, at a distance of 12 millimeters from the end of the strip. The camera is set 4 feet above the piano, directly above the hammers, and an anastigmatic 1:6.1 lens is used. The height of the camera with this lens is so adjusted that the 4-inch film will cover the entire bank of hammers. Beneath the hammers is placed a bank of 18 60-watt Mazda lamps. A layer of glazed glass over the lamps diffuses the light and forms a support for the paper strips. A slit 2 millimeters wide and equal in length to the width of the film is placed in the camera between the film and the lens. This slit permits only a small portion of each paper tail—a section between the slit and the hammer—to be focused on the film. When the key is struck, the hammer moves toward the piano string and the slit in the paper tail allows the light to pass through to the camera. The passing of this slit leaves a dot photographed on the film.

When the hammer reaches the piano string and produces the sound, the entire tail has passed the region focused on the film and the light again falls upon the film, making a distinctive mark on the film. As soon as the hammer has struck the string, it immediately drops back to the position where the slit in the paper tail is within the region focused on the film. The hammer remains in this position, photographing as a narrow band on the film until the key is released. The movements of the damper pedal are recorded on a similar principle. The duration of each tone, whether due to holding down the key or holding down the damper pedal, is indicated with precision on the film.

The velocity of the stroke as indicated by the time of the hammer in passing 12 millimeters is taken as a qualitative and relative measure of stress or intensity of tone and is read in terms of millimeters.

The time line employed is somewhat of an innovation and will be described because of its possibilities for use in other types of apparatus. A neon lamp, built in the shape of an inverted U, is placed in the camera with the base of the U extending across the width of the film and separated from it by a strip of thin sheet brass containing a very narrow slit (about .5 millimeters wide) and as long as the width of the film. The neon lamp contains a small amount of mercury, giving a pale blue light to which the film is exceedingly sensitive. The lamp is operated by placing it in series with the secondary of a small induction coil. In series with the primary of the coil are placed one dry cell and a 25 dv. electrically driven tuning-fork. The latter makes and breaks the current in the primary of the coil 25 times per second, the neon lamp flashing only on the break. This arrangement gives 25 parallel lines to the second, each extending across the width of the film. At present, we are running the film at approximately 12.5 centimeters per second, which separates the parallel time lines by 5 millimeters. At this speed, measurements to .02 of a second can be made with accuracy, and measurements to .01 of a second with only a very slight error. Finer measurements can easily be made, if desired, by using a tuning-fork of higher frequency.

The value of parallel time lines, each of which entirely crosses the film, was realized some time ago by Dodge.[1] Time lines of this kind are especially convenient in this apparatus when it is desired to measure such factors as the beginning, ending and duration of the notes within a single chord.

In addition to its use as a means of analyzing artistic piano performance, the apparatus may also be used to secure an objective measure of motor rhythm under an actual situation where this ability must be used. In short, it records quantitatively, with adequate precision, the temporal aspects of tone production on the piano and furnishes a serviceable indication of relative stress, so that all the elements of rhythm in any degree of complex musical movement may be analyzed for interpretation. The other two factors, pitch and timbre, are controlled by the

[1] Raymond Dodge, "A Pendulum-Photochronograph," *J. Exp. Psych.*, 9: 155–161, 1926.

piano itself. The film, therefore, furnishes a full and adequate record of piano performance.

This preliminary notice of the camera was sent to this journal because it was felt that the method here employed has many possibilities for application in other fields of science.

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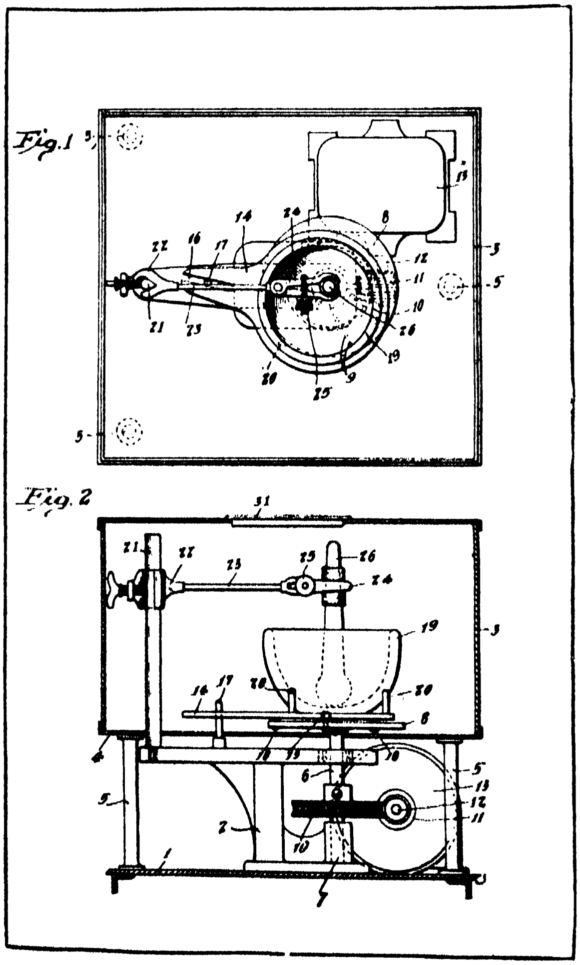
A NEW MECHANICAL DISINTEGRATOR

INVESTIGATORS working with filterable viruses appreciate how much time may be consumed in reducing virus tissues to a finely divided physical state, a task generally carried out by hand with the aid of a mortar and pestle. This method of grinding tissues is not only comparatively inefficient but also exceedingly monotonous and tiring. In order to overcome these objections in our own work, we designed a machine some time ago whereby the mortar and pestle could be operated mechanically. This apparatus has proved so satisfactory that we offer a brief description of it for the benefit of those who may be interested.



FIGS. 1 and 2

Fig. 1 gives a top view and Fig. 2 a lateral view of the machine. It consists of a suitable cast-iron pedestal (2), provided with a thrust bearing (7), into which is fitted a shaft (6), which passes through the floor (4) of the grinding chamber and bears at its upper end a driving disk (8) provided with several eccentrically placed apertures (9). Shaft (6) is driven by means of worm gear (10), which engages with a worm (11), attached to the horizontal shaft (12) of an electric motor (13). The machine is fastened to a metal base (1) on which rest also the legs (5) which support the floor (4) of the grinding chamber.

Within the grinding chamber a platen (14) is movably positioned above disk (8) by means of a pin (15) which fits into one of the eccentric apertures (9). The platen (14) is provided with a bifurcated end (16), which engages with a fixed pin (17) attached to the pedestal (2). The mortar may be fixed into position on the platen by means of rubber-covered metal fingers (20) extending upward from the platen (14).

The pestle (26) is held in position by means of a round flexible metal arm (23) provided with a clamp (24), operated with a thumb screw (25). The metal arm (23) is fastened by means of a special clamp (22) to a vertical triangular rod (21) fixed to the pedestal (2).

The mechanism described imparts to the platen holding the mortar an eccentric motion. By thus moving the mortar the pestle is brought into essentially the same operable relationship with the mortar as when the grinding process is carried out by hand. When desirable, grinding may be carried on under a hood (3), which may be entered by means of a hinged lid, provided with a glass window (31) to facilitate inspection of the material while the machine is in operation.

The machine described should prove useful not only in grinding virus tissues, but also in grinding most substances that are commonly disintegrated by means of a mortar and pestle.

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A METHOD OF TITRATING PROTEOLYTIC ENZYMES

IN 1927[1] the author published a brief note on a method of enzyme titration, which was later somewhat modified and demonstrated at the 1928 meeting

[1] *Proc. Soc. Exp. Biol. and Med.*, 24: 936, 1927.

of the Federation of American Societies for Experimental Biology. Since it has not yet been found possible to elaborate the technique, with protocols, in a longer article, as had been hoped, it seems best to publish these suggestions now and so to make them generally available for adaptation to individual problems in enzyme research.

The method is based on a reduction in the density of pieces of exposed photographic film by the release of silver through the progressive proteolysis of the gelatin layer. The relative densities before and after exposure to the enzyme solution are read against a suspension of the same gelatin-silver emulsion in a Duboscque type colorimeter, or by means of a photometer.

The film: Eastman Commercial, 8″ x 10″; 2 to 6 in a pile, irradiated by Roentgen ray, 50,000 v., 10 m.a., 25″ target distance, 2 min. exposure. (Small rectangles may be defined and numbered by lead strips and figures cemented to the cassette.) The exposed film is fully developed, fixed in plain hypo (no hardener), washed, dried, rewashed, dried again and cut into rectangles 2 x 2.5 cm.

The cells: No. 14 (1.5 mm) copper wire coiled around a 1.3 cm rod is snipped off in nearly complete circles (0.5 cm opening), bent flat and sealed with paraffin on 1.5 x 2 cm glass slips, with the opening on a 2 cm side. Backs are glass slips 1.5 x 2 cm. Cell, film and back are clipped together with a spring clothes-pin.

The colorimeter: A Klett, Bausch and Lomb or other Duboscque type is used, with spring clips under the tube shelves to hold the film carriers. These carriers are double leaves of thin brass, lacquered flat black, with centered 1 cm holes, between which the film is slipped for insertion under the shelf in the light path. The suspension for comparison is made of gelatin-silver emulsion, dissolved off of two films in hot water. Glycerin is added to 50 per cent. to delay sedimentation. A completely cleared film is used in the carrier under this tube. Fifty per cent. glycerin solution fills the tube above the test films. Both tubes must be at the same level when readings are made.

Method of use: Readings are made on each film before use, one film being reserved as a control. The others are each placed between a glass back and the copper ring of a cell, gelatin side to copper ring, and the whole held together with a spring clothes-pin. Enzyme solution is filled into the cell with a capillary pipette, and the cell placed upside down, gelatin film surface forming the roof, at constant temperature for a carefully timed interval. (A separate film is used for each determination desired.) Then the clothes-pin is released, the film is rinsed quickly in cold water and dried rapidly, clipped by one corner, before a fan. Units should be started at not less than fifteen-second intervals to allow for this rinsing of the successive films. When dry the density of each film is again read against the gelatin-silver suspension. Any change in the density of this suspension is revealed by a recheck on the control film, and the other control readings are corrected accordingly. Results are obtained in percentage of gelatin unaffected—the ratio of the final to the (corrected) control reading on each film. 100 minus this ratio, (*i.e.*, the percentage of gelatin affected) is proportional to the enzyme activity at the time and under the conditions of the test.

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SPECIAL ARTICLES

THE PRODUCTION OF HOMOZYGOTES THROUGH INDUCED PARTHENOGENESIS

BOTANISTS attempting to produce species hybrids have frequently obtained plants which resemble the maternal species exclusively. I have myself noted such results in various efforts to cross species of Nicotiana and of Fragaria. Obviously the most likely explanations of these phenomena (apart from certain special cases to which it is unnecessary to refer in this note) are (a) induced development of vegetative tissue, such as that of the nucellus, and (b) induced parthenogenesis.

More than a decade ago I endeavored to determine the true cause by an experiment on certain species of Nicotiana; but was unable to obtain positive results owing to the difficulty in finding satisfactory quantitative characters in the species employed. Some six years ago a similar experiment was started on the genus Fragaria. Two similar types of *F. vesca* ($2n=14$) were crossed, in order to study the inheritance of the contrasting characters, red fruit and white fruit, and pink flower and white flower. These characters proved to be due to independent pairs of factors *R* and *r* and *P* and *p*, in which dominance of color was virtually complete. Accordingly, a first generation hybrid RrPp was pollinated with pollen from species such as *F. chiloensis* and *F. virginiana* ($2n=56$). A number of maternals were obtained

exhibiting the gametic types RP, Rp, rP, and rp, thus indicating induced parthenogenesis. If induced nucellus division had been indicated, the resulting plants must all necessarily have been red-fruited and pink-flowered.

Owing to the extreme lightness of the pollen of all the strawberry species, the earlier results were questioned, and the experiment was repeated under the most careful conditions. Of twenty-four plants which have now fruited, twelve are red-fruited and pink-flowered, three are white-fruited and pink-flowered, seven are red-fruited and white-flowered and two are white-fruited and white-flowered. These plants are all diploids ($2n = 14$).

Naturally the possibility is not excluded that a portion of these plants arose through the division of vegetative cells. On the other hand, at least a portion—and perhaps all—of the plants must have arisen through induced parthenogenesis. That is to say, the beginning of development must have been haploid. This being true, the ensuing diploidy is most likely to have come about through ordinary mitotic division. The plants are therefore complete homozygotes.

As yet I can not say whether the breeding results corroborate these conclusions. It will take three years more to grow selfed progeny of each maternal plant. But in looking back over data on Nicotiana species recorded before the war, I find that as high as 100 seeds per capsule yielded maternals in certain attempted crosses where the full complement of seed per capsule is about 400. Notes, photographs and measurements show that the populations resulting from these seeds were extremely uniform.

Since the production of maternals is common in many species when an attempt is made to cross distant species, since some of these cases are certainly instances of induced parthenogenesis with ensuing diploidy, I am publishing this note with the hope that geneticists working with each of the important agricultural and horticultural crops will undertake similar experiments. If the technique can be improved so that a reasonable percentage of parthenogenetic embryos can be forced to develop, and if the majority of these prove to be homozygous diploids, the importance of the procedure to agriculture can hardly be over-emphasized.

I can give very few suggestions regarding technique; but perhaps the following points may be helpful. The indications are that (a) pollen which will produce tubes that will enter the micropyle are likely to induce parthenogenesis whether or not hybrids are occasionally formed; (b) parthenogenesis is not induced when the two species are so similar that hybrids are usually formed; (c) diploidy is probably the result of mitotic division of the chromosomes without nuclear division, division then taking place normally. Possibly X-ray or radium treatment or other stimuli will produce similar results. The main point to be guarded in experiments is to use mother plants having a genetic constitution that will permit easy detection of parthenogenetic diploids.

If this means can be used for the production of complete homozygotes, the labor of producing homozygotes through long periods of self-fertilization will be eliminated. First generation hybrids of homozygous stocks of many perennials such as grapes, blackberries, strawberries, apples, plums, etc., can then be tested out. Moreover, it would be possible to use homozygotes of annuals produced in this way for plot-testing experiments, for physiological researches and for determining residual variability due to external conditions.

Professor R. A. Emerson writes to me stating that for several years he has been endeavoring to secure haploids parthenogenetically with the hope that some diploid seeds can be obtained by selfing them. Professor L. J. Stadler also has been working for and obtaining haploids by means of treatment with X-rays. In this connection it might be pointed out that possible non-disjunctions, translocations, inactivations of small portions of chromosomes, etc., in haploids might reduce the probability of obtaining complete homozygotes in this way; whereas mitotic division of each chromosome at the first nuclear division of the stimulated egg-cell (if that is what occurs) would practically insure homozygosis. Second, certain experiments can be set up which would insure the detection of parthenogenetic haploids which would not insure the detection of parthenogenetic diploids. Experiments should be planned to detect both types.

E. M. East

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THE PRODUCTION OF BACTERIA-FREE AMOEBIC ABSCESSES IN THE LIVER OF CATS AND OBSERVATIONS ON THE AMOEBAE IN VARIOUS MEDIA WITH AND WITHOUT BACTERIA[1]

Since the cultivation of *Entamoeba histolytica* by Boeck and Drbohlav five years ago, a number of investigators have attempted to obtain this amoeba free of bacteria, but without success. Various dyes have been placed in the cultures with the hope of inhibiting bacterial growth without inhibiting the growth of the amoebae or without killing them. Also the cysts have

[1] Aided by a grant from the DeLamar Mobile Research Fund.

been washed and treated with chemicals before being placed in culture media. We have tried these methods, too, and mostly without success. However, when the cysts were washed in sterile (Berkefeld) filtered tap-water four or five times daily for ten days and stored at 2° to 4° C. while not being washed, it was possible on three occasions to obtain a few bacteriologically sterile amoebae after treating the washed cysts for three minutes with a 1–1000 solution of bichloride of mercury, and, after four washings, allowing the amoebae to excyst in fresh horse serum-saline 1–6. But the amoebae obtained were few in number, even though several million cysts were treated, for most of the cysts were killed by the treatment.

Practically every one who has attempted to free this amoeba of bacteria has felt that it would grow readily if separated from bacteria. But we have not found this to be true. None of the bacteria-free trophozoites which were obtained by the treatment given above lived longer than six days, and after the second day they were evidently abnormal organisms both in size and movement. But this may have been the result of the treatment employed.

So far as we know, no one has attempted to take advantage of the fact that the liver (of the cat) is capable of destroying many kinds of bacteria. We have found that it is sometimes possible for the liver of the cat to destroy the bacteria accompanying *E. histolytica* in culture and thus leave the amoebae in a bacteria-free amoebic abscess. This, of course, does not happen until the amoebae have been in culture for a month or more, probably on account of the fact that the bacteria are too virulent for the liver to destroy until they have been in culture for some time. Moreover, some pathogenic bacteria are probably overgrown and disappear from the cultures. All attempts to inoculate the amoebae directly into the liver from dysenteric stools have failed to produce bacteria-free abscesses; a majority of the animals inoculated in this way die within two to three days. It is possible, of course, that the inocula which we have used have been too large; had fewer bacteria and amoebae been inoculated, the bacteria, and not the amoebae, might have been killed. The inocula from dysenteric stools were from 0.2 to 0.3 c.c., and those from cultures were 0.5 c.c. each and contained about five million amoebae. Inoculation was made directly into the liver with a hypodermic needle following laparotomy. It was practically impossible to inoculate the amoebae into the liver without doing a laparotomy. The amoebae were cultivated on liver infusion agar slants covered with horse serum-saline (1–6) with a 5-mm loop of sterile rice flour added to each culture tube.

The best success we have had in producing bacteriologically sterile abscesses in the liver of cats was in a series of experiments in which thirty animals were inoculated. Of this number, abscesses developed in twelve, and the amoebae from eight of these abscesses were obtained in culture free of all bacteria. In many instances, however, the percentage of bacteria-free abscesses has been much smaller, sometimes not more than 5 per cent. being free of bacteria.

The following procedure was carried out in removing the abscesses from the liver and in testing them for bacteria. The cat was given ether and as soon as relaxation occurred was fastened to an operating board and the hair moistened with alcohol. When respiration stopped, the skin was removed from the ventral surface and the abdomen thoroughly seared with a large spatula. Then the liver was exposed by cutting through the abdominal wall with a red-hot platinum knife. That portion of the liver containing the abscess was severed with sterile instruments and the abscess placed in a Petri dish. Now, after searing the outer surface of the abscess and that portion of the liver which was removed with it, with a small platinum spatula, the abscess was cut into pieces from twice the size of a pea to one fourth this size, and these pieces were placed in tubes of sterile culture media, one piece in each tube. Many kinds of media were used and will be described presently. It was possible to inoculate from fifty to one hundred tubes from a single abscess, depending on the size of the abscess. The cultures were incubated aerobically and anaerobically for three to four days in determining whether bacteria were present or not. There is no doubt that some of the anaerobes which appeared in the cultures came from the liver of the cat instead of the culture (of amoebae and bacteria) which was inoculated into the liver, for it was possible sometimes to isolate similar organisms from uninoculated livers.

A fairly large series of experiments has been carried out in an effort to determine how soon after inoculation the bacteria are killed by the defense mechanism of the cat's liver. The earliest we have obtained the amoebae free of bacteria was seven days after inoculation. In our experience, from seven to nine days after inoculation is the best time to obtain the amoebae with no bacteria. We can not state definitely yet just what happens to the abscesses which contain no bacteria if the animal is not killed for examination, because we have not carried out a sufficient number of experiments. But the experiments which we have carried out indicate that soon after the abscess becomes free of bacteria it begins to heal and that within a few days, perhaps five to ten, no amoebae are present. This statement is based on

five observations: two where the abscesses were free of both amoebae and bacteria, and three where definite evidence of spontaneous healing was present.

As a result of the inoculation of the amoebae and bacteria into the liver, we have failed to produce abscesses in some instances while in other instances we have produced abscesses which ranged all the way from purely bacterial ones with no amoebae in them to those which contained only amoebae. In those in which only bacteria were present, the amoebae had probably been killed off or crowded out by the growth and activity of the bacteria, while in those where the activities of the bacteria were partly checked by the cat, it was possible for both amoebae and bacteria to live together as they do in the lumen of the intestine or in culture media. Whenever amoebae were present in an abscess, regardless of whether bacteria were present or not, there was no membrane or wall of granulation tissue at the edge or periphery of the abscess. This fact made it possible to tell at a glance whether amoebae were present or not. Whenever pus was present in the abscess, the amoebae were always found to be accompanied by bacteria. When a large amount of pus was present in the center of the abscess, as was sometimes the case when many bacteria were present, the amoebae were confined mostly to the outer portion near the uninjured tissue. But when no bacteria were present, the entire abscess was hard and dry and the distribution of amoebae was uniform throughout the abscess. In the abscesses which we have studied, there has been no indication that the amoebae ever bring about pus formation. However, if the abscesses were to run a long time—perhaps months or years as they are supposed to do in man—it is possible that pus might be formed.

We have estimated that each of the pieces of the bacteria-free amoebic abscesses which were placed in culture tubes contained from five to ten thousand large active trophozoites. These bacteriologically sterile amoebae have been placed in many kinds of culture media employed in the cultivation of bacteria, all the media that have been used in the cultivation of amoebae, and many others, but in no instance have they lived longer than fourteen days. There was some multiplication in several kinds of media, but the amoebae never multiplied so rapidly as they do when certain bacteria are present. The two kinds of media which gave the greatest promise of successful cultivation were: (1) egg slants covered with horse serum-saline (1–6) with one to three drops of laked blood added to each tube; and (2) liver infusion agar slants covered with horse serum-saline (1–6) with 1 c.c. of hydrolyzed haemoglobin and three drops of the sediment from autoclaved red cells of the horse added to each tube. Many substances were added to each medium, for instance, red cells of the cat, sterile cells from the liver, brain, spleen and kidney of the cat, rice flour, pure rice starch, various kinds of heat-killed bacteria, egg-white, egg yolk, glycogen, glucose, powdered milk, coagulated albumen, etc., but the amoebae were never successfully cultivated. In a few instances the growth of the amoebae appeared to be stimulated somewhat when the oxygen tension was reduced.

We have not spent a great deal of time in cultivating the amoebae with pure cultures of bacteria. In most of the experiments, a medium composed of liver infusion agar slants covered with serum-saline (1–6) and sterile rice flour has been used. After the amoebae had been definitely proved to be free of all bacteria, they were transferred to this medium and then the various bacteria were added. With some bacteria there was little or no multiplication of the amoebae. To this group belong certain of the spore-formers—*Bacillus megatherium*, *B. cereus* and *B. subtilis*—and *Proteus vulgaris*, *Escherichia acidi-lactici*, *Pseudomonas aeruginosa* and *Alcaligines fecalis*. With the spore-formers *B. niger*, *B. mesentericus* and *B. brevis*, the amoebae grew rather poorly for the first two or three subcultures, but after this they grew better and finally became abundant. They have been grown with *B. brevis* for almost a year and are no doubt capable of growing indefinitely. With *Escherichia communior*, *Vibrio comma* and *Neisseria catarrhalis* they grow well from the start.

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THE SPECIFIC ACTION OF A BACTERIAL ENZYME ON PNEUMOCOCCI OF TYPE III

A SYSTEMATIC search for enzymes capable of hydrolyzing the polysaccharides found in the capsular material of pneumococci of the various types has been carried on in this laboratory for several years. A number of enzymes from animal and plant sources, known to be active in the hydrolysis of simpler carbohydrates, were tested, but none of them were found capable of attacking the polysaccharides of pneumococcus origin. In addition, cultures of various moulds, yeasts, soil actinomycetes and bacteria, many of which were known to decompose cellulose, were tested without success. Recently, however, a bacillus has been isolated from the organic matter of soil taken from the cranberry bogs of New Jersey, which is able to split the specific capsular polysaccharide of pneumococci of Type III. The micro-organism is

a pleomorphic, Gram negative bacillus, motile and spore-bearing. A detailed description of the special technique employed in its isolation and cultivation, together with a more complete account of its biological characters, will be given in a subsequent publication.

From cultures of this bacillus it has been possible to extract a soluble principle which, in the absence of the living cell, decomposes this specific carbohydrate. The decomposition of the specific polysaccharide is indicated by the appearance of reducing sugars in the hydrolyzed mixtures and by the simultaneous disappearance of serological specificity. The rate of reaction and the total amount of specific substrate decomposed appear to bear a quantitative relationship to the concentration of the active principle.

The active substance present in the sterile bacterial extracts is heat labile, being destroyed by exposure to a temperature of 60° to 65° C. It is extraordinarily specific in its action against the polysaccharide of pneumococci of Type III, since the capsular carbohydrates of the specific types of Friedländer's bacillus, and even those of pneumococci of Types I and II, are unaffected. The fact that the reacting substance is a product of living cells, that it is specific and heat labile and that its action seems to conform to the laws of enzymatic reactions strongly supports the view that the active principle is of the nature of a specific enzyme.

The addition of an active extract to media does not inhibit growth or cause lysis of pneumococci; however, organisms of Type III, when grown under these conditions, are not specifically agglutinable in immune serum of the homologous type. That the *function* of elaborating the type-specific substance is not destroyed, however, is shown by the fact that pneumococci so treated continue to produce the capsular polysaccharide when transferred to a medium devoid of the active hydrolyzing agent. These two facts, namely, the decomposition of the specific carbohydrate removed from the pneumococcus cells and the hydrolysis of the specific capsular substance as rapidly as it is formed in growing cultures are evidence that the active principle is directed against this single, specific component rather than against the cell as a whole.

Previous studies on infection with pneumococci have led to the view that the invasiveness of these organisms is conditioned, in part at least, by the presence of the cell capsule. Since, early in the present work, the experimental evidence pointed to the fact that only the capsular material of the cell is vulnerable to the attack of this enzyme, it was tempting to determine whether the course of pneumococcus infection in a susceptible animal might not be favorably influenced by the injection into the animal of this specific enzyme. This possibility seemed more likely, since it was found that the activity of the enzyme *in vitro* is not inhibited or retarded by the presence of fresh animal serum. Repeated experiments with various preparations of sterile extracts containing the specific enzyme have demonstrated that the active principle has a distinct and specific protective action in mice experimentally infected with pneumococci of Type III. The protection afforded is type-specific, being effective only against pneumococci of this particular type. The protective value of the enzyme is destroyed by heating the bacterial extracts at 70° C. for 10 minutes. The capacity of any given preparation to protect animals against infection bears a definite relationship to its power to decompose the specific polysaccharide *in vitro*.

In addition to its protective action, the active principle has been found to exert a specific prophylactic and curative effect on experimental Type III pneumococcus infection in mice.

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Rene Dubos
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THE COMMERCE OF CHEMISTRY[1]

By J. N. TAYLOR

CHEMICAL DIVISION, BUREAU OF FOREIGN AND DOMESTIC COMMERCE, WASHINGTON, D. C.

I

A GLANCE at the pages of history will show the close relationship which chemistry has held with the advance of the human race. From earliest times, as evidenced by Biblical records, as well as by the monumental records of Egypt and the writings of Herodotus and Pliny, chemistry as an art played an important part in the life of ancient civilizations. Even as late as the fourteenth, fifteenth and sixteenth centuries the alchemical system attained wide-spread favor, and, as in the ancient Egyptian temples, chemical laboratories were to be found in Christian monasteries.

The chemist in the past has been somewhat inclined, like his illustrious predecessor, the alchemist, to lock himself up in his laboratory and keep his secrets to himself. In more recent years, however, he has come out into the light of day and now presents the results of his studies before meetings of our society and publishes his results in our journals.

Comment upon the retiring nature of the alchemists' successors, however, should not be taken in any sense as decrying the dispositions of our "fathers in chemistry" or deprecating their labors. None of us would think of criticizing the scientific habits of Boyle, Priestley or Bertholet; of Liebig, Kekule, Pasteur or of many of those who came after.

Many of these and other illustrious men did apply the results of their researches to practical ends, and the Industrial Revolution caused many industries to establish chemical laboratories at their own works. It was not until the trade associations came into being, however (particularly those forms of cooperative organization covering highly specialized fields), that capital may be said to have pooled its resources with

[1] An address delivered at Richmond, Virginia, May 2, 1930, before the Virginia Section of the American Chemical Society.

chemical science, looking toward the establishment of a community of interests. Scientific sections were organized, technical research instituted and the beginnings laid for studies that were later to advance both chemistry and commerce. To-day there is hardly a university in the country but has its fundamental and applied research available for industry or in the form of fellowships. For example, one well-known movement, sponsored by capital and initiated and administered by Professor Duncan first at the University of Kansas, later manifested itself in the establishment in 1911 of the Mellon Institute at the University of Pittsburgh with Dr. Duncan as the first director.

II

President Hoover, while Secretary of Commerce, in advocating and initiating the assembling of the \$20,000,000 fund for research in pure science to be expended over a ten-year period by the National Academy of Sciences, insured, in his characteristic, practical way, the continuation of industry's source of strength. The reservoirs of knowledge must not dry up. The streams and rivulets flowing into the power basin of commerce must continue in volume. Fundamental research must go on, and chemistry while continuing its industrial cooperative program must not be neglectful of pure science.

Nevertheless, while fundamental research is necessary for further progress and while applied science must continue to be fostered, the resulting products of discoveries and inventions so made must be distributed in order that those who wish them may have the opportunity to get them. It would seem therefore that just as the second phase of the Industrial Revolution called for the more intensive services of chemistry, so to-day, in still another phase of our industrial life, a new science has developed calling for a sympathetic understanding between chemistry and commerce, a mutual relationship between chemical production and distributive mediums. In chemical parlance, the relationship partakes of the nature of a reversible reaction in that the fortunes of the one are bound up with those of the other.

So the industrialist of vision establishes and maintains a department devoted not only to working out problems involving plant operations but also to the coordination of this department with other technical departments and with the development and sales organizations.

At the last New York meeting of the American Association for the Advancement of Science, Dr. Redman presented a very interesting study in which he discussed mortalities in the several stages of a product between the time of invention and the time of successful distribution. While one would not go so far as to say that all these deaths could be averted, it seems reasonable to presume that economic research should diminish the casualties. Obsolescence, the price of progress, can certainly be met just as problems of supply and distribution are met and surmounted.

This necessity for a larger knowledge of economic conditions as they affect the chemical industry has evolved a new order of workers made up in large measure of those possessing both commercial and chemical training. It has introduced a new chemist classification.

Perhaps it may not be necessary for the chemical marketing specialist to have a chemical training, but basic knowledge of chemical science and its nomenclature should be extremely helpful in considering the fundamental aspects of chemical processes, the relation of one product to another, the possibilities for new and more efficient applications of them, as well as a more intelligent understanding of economic and commodity trends. Through these influences and trends, chemistry is recognized as basic to all industry, and chemical industry to-day exercises a profound influence upon the political economy of the world.

III

Economic trends or commodity tendencies may be caused by several factors among which may be noted (1) the influence of other industries upon chemical evolution and (2) the intrusion of synthetics into fields of use already occupied by natural products. To these factors of outstanding interest to the chemist may be added (3) those of availability of natural resources and (4) waste and co-product utilization.

Consider how the automobile has affected chemical trends. It has caused a demand for more durable materials, for new and brighter colors and new and better protective coatings. These latter have demanded solvents answering certain exacting specifications. The automobile industry is responsible for the development of anti-knock agents used as motor fuel constituents embracing a variety of substances useful for that purpose. Increased production of artificial leather followed the greater output of motor cars. This greater output was also reflected in a larger consumption of synthetic resins. Another industry that has affected the trend of certain chemical commodities is the rayon industry. Rayon—itself a group of chemical compounds—has exercised an influence over cellulose and the acids, both nitric and acetic. The demand for acetic acid, for instance, increased to such an extent that calcium acetate had to be imported to satisfy the demand for the raw material, despite a continued growth in synthetic production as well.

Not so long ago the number of synthetics entering into competition with natural products was small, but

the rapid progress in chemical discovery adds new ones to the list almost daily. Ammonia, acetic acid, methanol, ethanol and the aromatics are just a few. Glycerin is confronted with glycol, and butyl alcohol faces internal dissension. Citric acid from fruits faces the constructive activities of the molds. The scene of natural camphor production will quite probably shift from the wild highlands of Formosa where live the head-hunting savages to more refined scenes of synthetic production.

Every state and territory in the union is endowed with a wealth of natural resources, ranging from mineral deposits to forests and power sources. Abundant deposits of salt and gypsum, pyrites and sulphur, are to be found in certain localities; oil, coal, gas and limestone, clays, phosphate rock and bauxite in others. In short, our natural resources comprise practically everything to be found in a text-book on economic geology. The animal and vegetable kingdoms, likewise, to a great degree contribute a variety of materials which after processing finally enter into commerce.

Utilization of wastes and collateral products is constantly changing our ideas as to what are main products and what are by-products. Once kerosene was the principal product of a petroleum refinery; now the situation is reversed. Hydrochloric acid at one time was allowed to escape as a waste gas. Uses found for it soon made it a main product. The oils obtained from by-product coke ovens are to-day in as great demand as the residual product of distillation. Chemical history is replete with these reversals in relative economic importance of manufactured products.

IV

The consequent appearance of new products and the larger application of both old and new ones have brought about a situation not comparable with that of any previous period in history. The incidence upon life of enormous quantities of materials having manifold uses must be characterized as truly great.

In the twenty-five-year retrospect of the American Chemical Industry, recently issued by the Chemical Division at Washington, and in Professor Munroe's great work on chemical technology prepared for the Bureau of the Census in 1899, there are presented more than the mere chronology and statistics of the industry. Considering these along with the younger Silliman's contribution to American chemistry, presented at the Northumberland celebration in 1874, it would be possible to write the history of American chemistry.

The magnitude and scope of chemical industry to-day is tremendous when compared with that of a hundred years ago—even indeed within the past quarter of a century. A comparison of the 1899 production figures with present-day ones will afford an idea of how far we have traveled since that time.

Consider just a few outstanding examples:

	1899	1927	
Acetic acid	$ 400,000	$5,500,000	(for sale)
Nitric acid	1,500,000	3,500,000	"
Sulphuric acid	7,300,000	43,000,000	"
Mixed acids	1,100,000	3,800,000	"
All sodas and compounds	11,600,000	114,000,000	
Alums	2,400,000	9,500,000	
Cyanides	1,600,000	6,300,000	
Fertilizers	42,000,000	190,000,000	
Paints and varnishes	54,000,000	500,000,000	
Explosives	17,000,000	72,500,000	
Plastics	2,100,000	28,000,000	

Sulphur, in the 1899 figures, included pyrites, and production aggregated a value of $543,249. The 1927 production of sulphur alone was valued at over $38,-000,000.

Rayon, first exhibited at the Paris Exhibition in 1889, is now a firmly established industry, total United States production in 1927 amounting to $110,-000,000.

Medicinal and toilet preparations, crude drugs, essential oils, waxes, matches and a multitude of other commodities have also seen a remarkable development.

We can not leave this discussion of the rise of the American chemical industry, however, without mentioning a branch constituting a key industry and occupying an important position in the chemical life of the nation—the synthetic organic chemical industry. In 1880, when the first mention was made in the census returns of coal-tar dyestuff manufacture, production amounted to 80,518 pounds of aniline dyestuffs. Expansion since the World War presents a magnificent record, preliminary figures for 1929 indicating the production of domestic dyes to have been approximately 110,200,000 pounds. Production of organic photographic chemicals totaled 581,000 pounds; synthetic flavors, 2,290,000 pounds; synthetic perfume materials, 1,596,000 pounds; synthetic phenolic resins, 31,471,000, and synthetic coal-tar medicinals, 5,000,-000 pounds. An industry that can offer to purchase for a country, with one of its secret remedies, great areas in the tropics is not an industry to be neglected.

We have compared the present with the past in terms of production. A story of the expansion of our foreign trade would also read like a romance.

To-day the world is our market-place, and we are sending to all parts of the globe chemicals and allied products valued at over two hundred million dollars a year. On the other hand, our imports of materials for use in chemical and allied lines aggregate over

two hundred million dollars annually, two thirds of which are either exotics or supplements to our inadequate domestic supplies requisite for the promotion of our industry.

The saturation point is not in sight. Production is limited only by human needs and desires, and our economic horizons are constantly being pushed back in order to supply the rational cravings of teeming millions not yet acquainted with modern necessities, to say nothing of some of the luxuries.

V

The forward movement in American industry has been accelerated in recent years by a greater Southern participation. The creation of a New South, a new industrial South, has resulted from a recognition of its vast potential resources and the availability of cheaper power and new methods and lines of transportation. Other contributing factors are the supply of native labor, freedom for expansion and widening markets. This new state of affairs is reflected in a production value for all industries in the South in 1927 (the last census year) of $10,371,000,000, about one sixth constituting chemicals and allied products.

The textile industry particularly has exhibited a southward movement and the processing of natural fibers and the manufacture of artificial ones—essentially chemical processes—has been an important development. The cheese industry since the practical eradication of the cattle tick has moved in a southerly direction. Coincident with these migrations there has been the establishment of other new industries. Expansion of old ones is reflected in the carbon black and the naval stores industries, and to the vegetable oil industry has now been added tung oil. Finally to supplement increased phosphate rock production we have another fertilizer material—fixed nitrogen—added to the South's list of products. Carbon bisulphide is expanding; diphenyl is no longer a laboratory curiosity, and cotton seed bran, the lowly peanut-hull and the Jerusalem artichoke will probably be converted into xylose on a commercial scale.

VI

Statistical data for the South in general and Virginia in particular have been so admirably presented by one of your section, Dr. Hitchcock, that it is unnecessary here to more than mention the leading position occupied by Virginia in the production of chemical and allied products and to note some opportunities worthy of consideration.

"Down where the South begins," here in Virginia, you have entered into a new age. Already known as the "mother of industry on the American continent," the state in which "were established the first salt plant, the first glass works, the first leather tannery," you now have added another type of "first," first in production of rayon. You will also, it is said, soon be able to guarantee United States independence of foreign nitrogen.

In 1927, the value of all products manufactured in Virginia aggregated $671,000,000, a 14 per cent. increase over the total 1925 value. Of the 1927 value, chemical and allied products aggregated $129,000,000, divided into twenty groups, illustrating the diverse nature of Virginia enterprise.

At the same time, what has been done represents only a portion of what may be accomplished. A booklet recently issued by the Virginia State Chamber of Commerce impresses one with the great potentialities awaiting development. Water and rail serve not only a section that may be glimpsed from the deck of any steamer coming down the bay or in through the capes but a vast territory to the north, west and south, as well.

Hampton Roads Port is a gate of ingress to the West and South, and it is one through which a steadily increasing outflow of all sorts of materials will find their way to foreign fields. The Hampton Roads Port is especially favored by its location and the nearness to the east and west coasts of South America and by the territory which it is capable of serving. Mutual requirements of this area and the United States should ensure cargoes coming and going.

In the export studies included in the traffic survey previously mentioned is one on coal, and the thought occurs that some could be processed in ovens and the by-products utilized. Coke production could mean a metallurgical industry, and an increased tar production could mean more road materials and more domestic creosote with a short haul and perhaps an expanded creosoting industry. The manufacture of other products ranging from crudes to finished products, from motor fuel constituents to dyestuffs, is not incapable of consideration. The import study on cacao beans suggests theobromine and caffein, this thought in turn suggesting the field of fine chemicals. The molasses study not only suggests industrial alcohol but also images the booming solvents industry. Reflection upon the pork and pork products study visualizes slaughtering and packing-house activities, with consequent production of biologicals, soaps and glycerin.

In addition to these suggested lines of chemical endeavor may be added casein, not only to supply the coated paper industry, but also as a basis for the casein plastics now finding wide application.

VII

Suggestions such as the few just given inadequately present our possibilities. They seem so very meager. Could we but transport ourselves into the future—let us say to 1950—we should, no doubt, be amazed at

what had happened in the intervening score of years.

The historical glance backward has shown us the great forward strides made since earlier times by American chemistry. We are quite aware too that scientific discovery and invention are proceeding at an ever-increasing rate, and in the light of history our progress in the future is to be more rapid than in the past.

The functions, then, of chemistry in the future must be more comprehensive than at present and must certainly embrace an understanding of its economic importance. The service of chemistry must be not only in the discovery and the application of scientific and technological facts, but chemistry must also serve by solving the larger problems of distribution in its broadest sense. We must lay more emphasis upon the commerce of chemistry, upon the economical distribution of chemical wares. New uses must be found for old products. Old industries may justify expansion, and new ones would logically be inaugurated if deemed advisable.

It is not enough to visualize the great potential awaiting development—to view the perspective—and stop at that. Practical and efficient methods for bringing about the desired ends must be formulated, and happily, chemical industry itself, as well as governmental institutions, have made a beginning along this line.

A general method of approach, capable of specific application, of arriving at a program of effort, is through the chemical-economic survey. Such a survey, when completed, should show fairly conclusively whether or not a given material shall go into production, how long an industry can continue its current program, whether it should switch immediately or gradually or whether it should pick up and move to some other part of the country.

In building the survey structure the technique to be followed will, of course, depend upon the problem at hand, but no matter what the survey, whether of some particular branch of industry or of some particular commodity or group within the industry, the foundation upon which the superstructure is to be raised must consist of immediate, reliable, adequate and permanent records.

VIII

The Department of Commerce, because of its relation to other government establishments and to industry, has at hand or can point the way to the many sources of information so important in determining the position or status of a specific chemical industry or commodity, or in determining their trends. Cooperation in this respect is gladly accorded through the Chemical Division of the Bureau of Foreign and Domestic Commerce, which, established eight years ago by Mr. Hoover when he was Secretary of Commerce, with Mr. Concannon as chief, endeavors to render practical service in the application of commerce to chemistry.

Nearly every day one or more interesting problems are presented. Some one may ask, "How are the solvents?" or "What is the future of acetic acid and how?" Or the question may be, "Where and in what quantities can rotenone-containing plants be found? Has it been synthesized yet?"

The functions of the division are essentially trade promotive and do not include any of a regulatory nature. Through regional surveys and immediate services available in fifty-eight American cities the bureau assists domestic commerce. To promote foreign commerce the bureau also has available the services of its fifty-six offices abroad and the collaboration of the consular service.

The information thus made available covers a multitude of points: Magnitude of the situation as affected by foreign competitors, climatic conditions, advertising, make-up and habits of the population, purchasing power, chemicals and allied products manufactured locally or other sources of supply. Questions related to transportation facilities, customs tariffs and internal regulations affecting the importation or sale of American products in oversea countries are looked into and reported upon.

In addition, the bureau maintains lists of prospective agents in each country and keeps a complete commercial report on each one for the confidential use of American firms. Not only is up-to-date information given regarding trade conditions, but each week the bureau publishes a number of "trade opportunities," which are inquiries from parties with a definite interest in buying who wish to get in touch with manufacturers here.

A thousand men are at your service in the four corners of the world to gather together data bearing directly upon foreign trade promotion, and at the Washington headquarters and the district and cooperative offices throughout the country you will find the department's facilities at your disposal.

OBITUARY

GEORGE NEIL STEWART, PHYSIOLOGIST

April 18, 1860, to May 28, 1930

BY Stewart's death science has lost a brilliant physiologist "of the old school," a pioneer, a builder of bridges between the founders of modern physiology of the modern era. He was a pupil of the old masters, but most of all he was a scientist of high merit in his own right and a man of personal great-

ness. He was a constructive force in physiology, a master of the subject, of its literature and its technique; an independent and critical thinker of deep insight, a conscientious and resourceful investigator, a brilliant educator of students and teachers and investigators, the author of a classic text-book.

Devoted to his work, he led a very retired life, especially in his later years, and made few personal contacts outside of the immediate circle of his friends and pupils. Toward the end he became a rather remote figure, especially to the younger generation of physiologists—and to their loss, for he was a great and inspiring teacher. Even in this personal remoteness, however, he exerted a great influence on the development of physiology in English-speaking countries, by the pupils whom he has formed and by his text-book, which introduced so many medical students to the subject. The book was the man and the subject. It breathed and lived the spirit of modern physiology, of the science and functions of life. It presented the point of view, the methods, the results, of the science in a simple, lucid style which made the most difficult things plain and interesting, and within the reach of all. It supplemented the didactic exposition with "practical exercises" which motivated and recast the laboratory teaching of physiology. In the book and in himself, Stewart typifies an important period in physiology, the transition from the dawn of physiology as an exact science of broadly applied physics and chemistry, to the present period of more detailed specialization. He carries us back to the days of largely diversified interests, when a man could still claim all physiology as his province; he helped to carry its spirit into a new country and into a new century. In this he was not alone; there were other pioneers and other bridge builders, and we are grateful that a goodly number of these are still with us. However, Stewart's significance went beyond his period; it lay largely in his personality, and its reactions with science.

I had started this memorial with a chronologic history of events in Stewart's life; but with a man of his inner individuality, externals are mere accidents, and so he regarded them. This small esteem is illustrated by the minor disagreement of the dates in his biographic calendar, in "American Men of Science" and in "Who's Who." What matter to the man whether he received his M.A. in 1881 or in 1883; one would serve him as well as another. External events were but a net on which to weave the pattern of his life. They were not vital, they scarcely show through the final design, and yet they must have guided it to a large degree. Man is like Faraday's atoms, a mere meeting point of forces, external and internal, and is formed by their interaction. To understand Stewart, therefore, it is well to attempt to list the chief external events in the order of time:

Born, London, Ontario, April 18, 1860.
Assistant in physics, University of Edinburgh, 1879–1880.
M.A., University of Edinburgh, 1881 or 1883.
Mackay Smith scholar, 1883–1884.
B.S., University of Edinburgh, 1886.
Studied in Berlin, 1886–1887 (with du Bois-Reymond).
D.Sc., University of Edinburgh, 1887.
Demonstrator of physiology, Victoria College, Manchester, 1887–1889 (under Wm. Stirling).
M.B., University of Edinburgh, 1889.
George Henry Lewes student, University of Cambridge, 1889–1893.
Examiner in physiology, University of Aberdeen, 1890–1894.
D.P.H., University of Cambridge, 1890.
M.D., University of Edinburgh, 1890 or 1891.
Studied in Strassburg, 1892.
Instructor in physiology, Harvard University, 1893–1894 (under Bowditch).
Professor of physiology and histology, Western Reserve University, 1894–1903.
"Manual of Physiology," first edition, 1896.
Professor of physiology and head of the department, University of Chicago, 1903–1907.
Married, to Louise Kate Powell, September 20, 1906 (four children).
Professor of experimental medicine and director of the H. K. Cushing Laboratory, 1907–1930.
"Manual of Physiology," last revision, 1918.
LL.D., University of Edinburgh, 1920.
Died at Cleveland, Ohio, May 28, 1930.

Stewart was born in Canada, but the family soon returned to Scotland, and he was brought up in Lybster, Wick, a little fishing village on the North Sea. The character and occupation of the people left a powerful impress upon him. He was fond of recalling the romantic adventure and hard work of the herring fisheries, the bustling markets and the cooperage. By race and contact and inclination he took on the strongly marked characteristics of the Scotch villagers, their sturdy gospel of hard work and stern devotion to duty, asking little of life and giving much; their industry and self-control and self-denial and honesty and self-respect and independence and veneration of learning. The scholar was the man respected, and Stewart early showed that he was a diligent learner and a clear thinker. He gathered a goodly stock of honors, prizes of books and medals, which pleased his family, and later of scholarships and posts of more substantial worth. Thus he laid the foundation for his career, in the medieval manner of the small village, and carried a load of boyish learning to that medieval citadel of classicism, old Edinburgh, the greatest city of Scotland, and thus of

the world. It impressed him much as the medieval university towns impressed the medieval students. The training began with the classics and philosophy and history and mathematics. The classical languages were probably a duty rather than a choice, but when he went to the Continent and presented himself to a professor whose knowledge of English was as theoretical as Stewart's training in German, they both found it easier to converse in Latin—a striking illustration of the educational changes of the last fifty years. History remained a means of relaxation to the end. Mathematics ever appealed to his sense of order and clearness and logic. It is often the gate through which a studious mind is introduced to science, and as is so often the case with a studious mind, it led him into science by way of physics. With his industry and intelligence, he stepped quickly across the gulf that separates the receptive from the active student, and became assistant in physics, to Tait, the brilliant experimenter and popular lecturer and writer.

As most scientists of those days, he took up the study of medicine to assure his future bread and butter. At that time, physiology was taught at Edinburgh entirely by formal lectures, as if it were history or philosophy; but Rutherford had done some experimental research, especially on bile flow, and a small group of students persuaded him to give them a course of demonstrations. This was Stewart's initiation into physiology. He was attracted by its boundless possibilities for the application of exact scientific methods of working and thinking to problems that appeared worth while, and he turned aside and stretched out his medical course so that he could devote himself to physiology. Through his training in physics he became particularly interested in the electrophysiology of nerve, and he spent his first year abroad with the master of that subject, du Bois-Reymond, in Berlin, in 1886 to 1887. On his return he took the doctorate of science at Edinburgh, and launched definitely on the physiologic career, but later, with Sotch caution, took also the M.D. at Edinburgh and the D.P.H. at Cambridge.

The next two years, after his return from Germany, he spent as demonstrator of physiology with William Stirling at Manchester, and obtained excellent experience in teaching methods. Stirling made a sacred cult of the illustrated lecture; and there is perhaps no better method of learning the technique and the phenomenon of a science than that of being responsible for a demonstration course. One learns to feel the importance of visualization, of the senses, as aids to understanding; one learns to think in terms of actualities instead of abstractions; and the variety of technique calls forth ingenuity and inventiveness. The wide field which must be covered in a limited time prevents narrowness and pigeon-holing. Matters are brought into apposition while they are still fresh in the mind, and in the best condition for forming connections. There is no method of preventing narrowness in a science more effective than the yearly repetition of a course illustrated by experiments. Such experiments never grow stale, at least in the biologic sciences. Incidentally, the department of physiology was further broadened by the inclusion of histology, and much of what now goes to biochemistry. The subjects have meanwhile grown so much that their union under one man would lead to superficiality; but so long as it was feasible, the inclusion of these three aspects of life, morphology, physics and chemistry, did tend to prevent narrowness of vision and specialization. Perhaps that is one reason why the investigators of that generation were apt to diffuse themselves. Nature appeared so full of various things that it was difficult to set bounds to one's interest. There were continents to be explored, while now the task is more that of the intensive development of a territory, or a mine or a chamber of a mine.

After his apprenticeship in teaching, Stewart devoted himself to research, chiefly at Cambridge, with another experience in Germany, this time at Strassburg (1892) where he formed a friendship with Cushing. In 1883 he accepted an invitation of Bowditch to come to Harvard as instructor of physiology. The experience was a happy one. He was charmed by the kindly, high-minded Bowditch, whose cordial hospitality made a stranger at home; and his imagination was captivated by the possibilities of the land, still so virginal in regard to science, so unsophisticated, so eager. He desired to prolong his stay, and embraced the opportunity which presented itself, before the year was up, by the tender of the chair of physiology and histology at Western Reserve University. Thus end Stewart's wander-years, those years of flowering freedom, when experiences and impressions are gathered and stored and worked over, when the character is forming, and plans are pushing forward, waiting for realization, crystallizing from dreams to substance.

In 1887 Mr. John L. Woods, of Cleveland, who had made a fortune in lumber, conceived the then revolutionary idea that a most useful application of wealth to the benefit of humanity would be its investment in medical education, a commodity which stood in great need of improvement. To this end, he built a monumental stone building, in the perfection of the period, for the Medical School of Western Reserve University, and founded an unconditional endowment of $125,000, one of the very few and one

of the largest medical foundations of the time. The Medical Faculty accepted the princely gift with grateful appreciation, and doubtless also with some misgivings; there was so little precedent! Some thought that the income should be distributed to the teachers, which meant the practitioners who were giving part-time clinical instruction. Others felt that this was a great opportunity to install the laboratory system, whose sun was shining abroad, especially in Germany. Could not the sun be brought to rise also in America, in Cleveland, at Western Reserve? The visionaries won; as usual, the visionaries were chiefly the younger men; and as usual, they had no fear of youth. In 1893 they secured Carl A. Hamann, aet. 25, for the chair of anatomy; and in the next year, William T. Howard, aet. 27, for pathology; and Stewart, aet. 34, for physiology. Stewart came to Cleveland to size up the situation. He liked the faculty, and he was greatly impressed with the building. Here, he told later, was a substantial place that would withstand the siege of the Indians, aye, and would be sturdy for centuries to come. It might, were progress not more destructive than the Indians. The building has been razed, and salt sown in the furrows, because the parking space was more valuable than the fortress.

Stewart took hold of the job with the enthusiasm of the young wrestler. The chance to do stirred his imagination; the task to be done spurred his sense of duty; the warm admiration of the students called for his affection; a group of younger workers, Howard, Hamann, Hoover, supplied the comradeship, the understanding; the friendly deference of the older colleagues gave him confidence. All that was Stewart warmed to the occasion. He was busy, supremely busy, but perfectly happy. The conditions, physiologically speaking, were those of the frontier, and Stewart would have been justified in spending a year in studying the situation and laying plans, and perhaps starting to develop some one feature; but his conscience did not permit him to slight anything, to defer to next year what could by any chance be done now. He had few resources except in himself, but that was enough. For apparatus, for personnel, he had chiefly his own boundless energy. It served him as the genii of the fables. He was roughing it—the greatest stimulus to men of strength and independence. The tale of his first year would be as a tale of Crusoe to these modern days. We have become dwellers in civilized and populous cities. We have gained much in externals, in machinery, in speed, in directness, in accuracy; but we have lost something of the spirit of things, of self-reliance, of adventure. Have we gained more or lost? Perhaps the question is unanswerable, or not worth answering. Our lives are cast in the present, and our dreams are dreams. The current of time and events sweeps on; the towered castles that were picturesque in the upland become vain ostentation in the plain.

The first year in Cleveland was filled and over filled with teaching; but on top of this Stewart managed to write his text-book, which he put through the press during the next summer's "vacation." It is a measure of Stewart that the book bears no trace of the pressure under which it was produced. Substance, style and proof-reading are as nearly perfect as if they had been the author's sole occupation, with time unlimited. When the book was completed, Stewart took no time for rest, but turned to research the energy and time that was released. Aside from these activities in physiology, Stewart took an active part in the forming of the important faculty policies, including the lengthening of the course from three to four years, and the requirement of an academic degree.

Thus passed ten full, busy, happy years. In the meantime Harper had started a great university in Chicago, with emphasis on graduate work. There Jacques Loeb had founded a school of physiology, temporarily divorced from medicine, with brilliant disciples. Loeb, however, desired to be relieved from all teaching duties, and had gone to a post of pure research in California. Harper was planning a medical school, and with the assistance of Barker, was seeking as successor to Loeb a physiologist who would be interested in the medical school as well as in physiology. Their choice fell on Stewart, and he again saw another, a broader opportunity and accepted. The change did not come altogether easy to him. The greater centralization was somewhat irksome to his individualistic temperament. The restrictions which were deemed necessary to the effectiveness of the larger organization cramped the man who had become accustomed to the complete liberty which prevailed in Cleveland. These matters were gradually adjusted, but in four years Cleveland secured Stewart's return by organizing a somewhat novel experiment, the H. K. Cushing Laboratory of Experimental Medicine, for the application of the method of scientific investigation to the problems of the clinic. Clinical research was lagging definitely behind the advance of the laboratory subjects, chiefly because the active practitioners who were in charge of the clinics lacked the time and often the special training for the application of the methods of physiology, of physics and of chemistry. There were no full-time salaries in the clinical positions; and even had these been available, there were few if any men who would have been properly prepared to take them. It appeared necessary to try another experiment; and it seemed worth while to establish special liaison

foundations, and Stewart, with his broad interests, appeared the man to place in charge of such an experiment. It appealed strongly to him, and he accepted. He was happy to return to Cleveland and to found a field of useful activity, although the experiment did not work out quite as it had been planned. The difficulty was largely intrinsic. The condition of success was enthusiastic collaboration between the laboratory and clinic on a basis of equality. Collaboration may be fruitful on a basis of subordination; but equal partnerships remain enthusiastic only if they are spontaneous. They are chilled by official assumption, and as enthusiasm wanes, difficulties arise. Stewart, therefore, made the activities of the laboratory self-containing and turned especially toward the functions of the adrenal gland. His later years were afflicted with ill health, an anemia with progressive spinal degeneration, which hampered his physical activity; but he kept mentally alert, and in our last conversation he repeated to me how much he liked to continue in the work.

And so, having completed the course, let us turn back and attempt once more to seize Stewart's significance to physiology. His career started when that science was passing through a formative period, especially in America. Such periods bring out the strength in men; the stuff is more plastic and takes impressions more easily; and there being fewer competitors, the impressions stand out more strongly. But Stewart's significance went beyond his period. It was a part of his personality, a something which contains intangible elements, but which also has some tangible features. Stewart's was an impressive figure in science, chiefly because he possessed to a high degree the chief characteristics of the scientist. It may, therefore, be worth while to examine these features in him. First, I would place intellectual curiosity, eagerness to know, to comprehend, this wonderful world. This desire was insatiable; everything was full of interest, presented questions, pressed for solution. His was the religion of the investigator, the scientist's faith in the value of knowledge, *per se*, of facts—provided that they be facts. This was the second feature in the personality: rigorous conscientiousness in the pursuit of truth and punctilious devotion to duty. The third feature was a keen mind, analytical, critical and logical, which led his path through the mazes of data and theory. Then came an exhaustive, encyclopedic command of the literature. To the end, the journals were conscientiously read, each paper critically sifted, abstracted and filed in due order. His judgment was reliable, severe but just in all his relations, every fact and every action received its exact due, no more, but also no less. One of his most strongly marked features was his clear exposition, the natural projection of his own mental processes. What he thought, he thought clearly; the lights and twilights and shadows each had their exact value; and what was so clear to him, he had no trouble in making clear to others; he need merely to lay it forth, to open his mind to inspection. In his teaching, as in his book, there was never a doubt as to Stewart's meaning; nothing was slurred; each datum was set forth, weighed and appraised, each argument defined. This was settled, that dubious; so much was on this side, so much on that; you could lay a wager on the odds. There was still something further, an unusual facility of thinking. To Stewart's mind, direct and logical thinking was as natural, as easy as breathing. The current of his thought flowed smoothly and rapidly and clearly. He could write and talk extemporaneously as well as after long preparation, or indeed better, for the extemporaneous had the warmth of life, and his delivery was enlivened by his whimsical dry humor, supported by an inexhaustible fund of anecdotes. The extemporare in Stewart's delivery and writing, however, was merely in the form, in the expression, in the vestment. Behind it lay thorough preparation of the substance. The material for his lectures and demonstrations was prepared with the thoroughness and attention to details which he had learned in the Stirling days. He exacted similar thoroughness from his students, and he was a master in exposing the slipshod. With a few artistic moves he peeled off the cloak, the skin, the muscles, the bones, and reduced the hapless victim to a shadowy cloud; and all this with such evident absence of malice that a culprit learned an unforgetable lesson without taking offense; the lesson of clear, straight, logical thinking, based on facts obtained from reading and from the original source in the one true sense, experimentation. The latter was the special aim of the practical course, to give to the students the opportunity of first-hand observation of phenomena, of as many phenomena as possible, to acquire an ample fund of experienced and visualized things as stuff for thought. The importance of this was especially great in the earlier days, when it furnished the only direct contact with life, in the entire medical course; even the clinical work was then taught almost entirely by "theater" demonstrations. Stewart, therefore, introduced considerable work on mammals, an innovation in those days, and of experiments on the students themselves. Times have changed; the medical course now includes much more laboratory work, but it is distributed among all the subjects, and, therefore, must be supplemented more extensively by demonstrations.

Research, Stewart regarded as indispensable to the self-respect of the scientist; as the thing that lifted

him above the common herd, and by which he set a marker in the flow of time. It was his religion. To it he brought conscientiousness, logic, imagination, ingenuity and a background of reading and wide knowledge of what had been done and thought and erred. The diversity of his interests is illustrated by the subjects that come to my mind. In the pre-Cleveland days: color vision, electrophysiology, cardiac nerves, circulation time estimations by the dye method; in the first Cleveland period: otoliths, muscle proteins, electric conductivity and its application to the circulation time, permeability of the blood corpuscles as simple forms of life; in the Chicago period: resuscitability of the central nervous system; in the Cushing Laboratory: further studies of permeability, calorimetric measurements of blood flow, epinephrine output, suprarenal deficiency. All these show careful work and diligent accumulation of data. It is too early to judge their ultimate usefulness.

After all, however, the greatest significance of Stewart is his influence on his students, his pupils and his associates. They are all different, and better, for having been exposed to him, his high standards, his meticulous methods, his comprehensive points of view, his critical logic. I had the privilege of being the first in time; most of his other Cleveland pupils went into practice, except Guthrie, who followed him to Chicago. There his chief disciples were Carlson and Pike, and many others were partly formed by him. In the Cushing Laboratory he became associated with Marine and Rogoff and Dominguez.

To attempt once more a final evaluation, Stewart stands forth as a notable scientist of high ideals and eminent ability. His importance was not so much in his discoveries as in the standards which he inculcated. He promoted physiology as a whole. His teaching set a model of logical exposition, of clear thinking, of critical evaluation of data. He expanded the capabilities of the laboratory in the teaching of physiology. He hastened the appreciation of the experimental point of view in teaching and thinking. All who came in any contact with him were the better for the experience—which is perhaps the highest praise that can be given to any man.

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SCIENTIFIC EVENTS

THE DEPARTMENT OF ANIMAL GENETICS AT THE UNIVERSITY OF EDINBURGH

THE *British Medical Journal* reports the opening of the new department of animal genetics of the University of Edinburgh on June 30 by Sir Edward Sharpey-Schafer, F.R.S., under the presidency of Principal Sir Thomas Holland. Sir Edward Sharpey-Schafer, before declaring the buildings open, gave an address. Professor F. A. E. Crew, in presenting Sir Edward with a key to perform the opening ceremony, referred to the important work of Professor Cossar Ewart, who, he said, was fortunately present that day. Professor Ewart might well regard this department as his own creation and the realization of his dreams. The ceremony also included the conferment of the honorary degree of LL.D. upon Mr. Thomas Bassett Macaulay, president of the Sun Life Assurance Company of Canada, who had made a series of gifts to the department. In presenting him the dean of the faculty of law mentioned that, like Lord Macaulay, the present recipient of the degree was descended from the Macaulays of Uig in the island of Lewis. His father had emigrated to Canada, where their guest had built up one of the foremost insurance corporations in the world. After the degree had been conferred Mr. Macaulay said that the study of endocrinology had been one of his hobbies for at least twenty-five years. This might seem a strange recreation for a layman, but his object had not been the acquisition of knowledge of merely theoretical value. Medical science had made marvelous progress during the last two generations in combating disease, chiefly in improved sanitation and in the knowledge of the nature of infection, but he thought that most of the great problems of non-infectious degenerative diseases of the latter third of life still remained unsolved. Great advances he felt reasonably certain would be made in the understanding of the endocrine glands during the next twenty-five years. He had been deeply interested in the splendid work that was being done in the animal genetics department of Edinburgh University and he was pleased that the biochemical department of McGill University was now actively cooperating with Edinburgh. He congratulated the University of Edinburgh on the part it was taking in the great work of the future. At a luncheon which followed the ceremony in the Library Hall of the Old University, Sir Thomas Holland mentioned that during the past two years Mr. Macaulay had given to the genetics department of the university contributions which amounted in all to £67,000; the university, he said, would endeavor to justify the confidence he had shown in its work.

The new buildings of the animal breeding research department of the University of Edinburgh are situated at West Mains Road. The original idea of this

department, conceived before the war, formed part of the plans of the development commissioners. After the war the plans were reconsidered, but shortage of money prevented development of the work on a large scale. In 1920 Dr. F. A. E. Crew, who was an assistant in the department of zoology of the university, was asked by Sir Edward Sharpey-Schafer, then chairman of the joint committee, to take charge of the embryo department, and a few rooms in the Old Infirmary buildings were devoted to its work. Here some sound scientific work was done. Studies on wool began in 1923, and studies on pigs in 1927, other subjects of agricultural importance being taken up later. In 1928, as the result of a gift of £30,000 from the International Education Board and of £10,000 from Lord Woolavington, the department was reorganized, and Dr. Crew was appointed to the newly founded chair of animal genetics. The buildings which have just been opened were then started. Their purpose is to provide facilities for work of a purely scientific nature which is expected to have an important effect upon agriculture in about fifteen or twenty years' time. At present inquiries are being undertaken into the inheritance of milk yield in cows, and into the ideal type of bacon-yielding pig.

THE GIANNINI FOUNDATION FOR AGRICULTURAL ECONOMICS AT THE UNIVERSITY OF CALIFORNIA

GIANNINI HALL, the gift of A. P. Giannini, built primarily to house the Giannini Foundation for Agricultural Economics, has been completed and is ready for occupancy by various divisions of the University of California College of Agriculture. At the present time, the Giannini Foundation will not require all the space provided by the four floors of the structure, and the college administrative offices, agricultural, extension, forestry and agricultural economics, will be housed there.

The building cost $500,000, and is the third of the agricultural group on the Berkeley campus. It is, in floor plan and shape, practically a duplication of Hilgard Hall. The building is 280 feet in length, 64 feet through the center, and the wings are 63 feet in width. In addition to university activities, cooperative offices such as the California Farm Bureau Federation, United States Forestry Experiment Station and the National Park Service will be housed in the building.

The director is Professor C. B. Hutchison, formerly director for Europe of the division of agricultural education of the International Education Board. Members of the staff in addition to Dr. Howard Ross Tolley, formerly chief of the bureau of agricultural economics for the U. S. Department of Agriculture, now professor of agricultural economics and assistant director of the foundation, include Dr. George M. Peterson, formerly of the agricultural economics staff of the U. S. Treasury Department, and Dr. J. M. Tinley, of the Department of Agriculture of the Union of South Africa. In September Professor Leland Spencer, of Cornell University, will assist the foundation in a special six-months' study of the milk surplus problem on which the local station is now working.

The station will attempt to put California agriculture and horticulture as a whole on a business basis, with the grower receiving the monetary return that his effort will produce. Through the Giannini Foundation, according to the announcement, it is expected that "the state will be in a position to take care of every phase of agriculture from the moment the farmer or grower starts in search of a suitable piece of land until his crops are placed on the tables of the ultimate consumers throughout the world."

STATE LANDS AND WILD LIFE OF WISCONSIN

THE development and utilization of the land resources of Wisconsin to the end of giving each man, woman and child an environment for a life pattern containing all the attributes of growth, beauty and constructive living is the dominant purpose of the Wisconsin Land Inventory program, according to John S. Bordner, who is in charge of the inventory and who gave an account of the project at a recent meeting of the Wisconsin Academy of Sciences, Arts and Letters.

Those areas least occupied for agriculture and already being zoned for other uses are being first evaluated, in enumerating some of the things done to coordinate these various factors and to aid in the administration of land for diverse uses. The depth of lakes, the nature of their water, glacial action, sources of ground water, geographical distribution of plants, soil genetics and the trend in forest succession are being taken into account.

Through these and many other studies it is possible to show how many acres there are which have worthwhile timber growing on them and how many have worthless brush or are sodded over with prairie grasses, how much swamp there is which will produce timber and how much is worthless for anything except to grow Christmas trees for the children of Wisconsin or to continue as a habitat of rare and beautiful plants.

We also have one crew of two men determining the age and rate of growth of timber of different kinds and on different soils. From this study, it is possible to calculate just what each kind of forest will produce

annually, and to make a comparison of the yield and value of timber with growth. The distribution of wild life and the nature of their habitat are also mapped and tabulated in the same census.

The best land for private ownership, in growing timber and for summer homes, the areas adapted for use as parks, forest preserves, game preserves, boys' and girls' camps, or for whatever purpose the state may use them, are delineated so that they may be entered for the purpose of constructive use and not in a chaotic manner as land was entered in the pioneer days.

Throughout his address, Mr. Bordner emphasized the necessity of a life pattern that is not limited to the bounds of a man-made environment.

We are concerned, therefore, with the evaluation of land for diverse uses, to which land can be and should be put by our present and future population in Wisconsin. The evaluation of land for agricultural and forest, industrial and urban use is vital, but there are other uses just as vital, if our civilization is to reach beyond the immediate future.

THE FIFTH INTERNATIONAL BOTANICAL CONGRESS

THE Fifth International Botanical Congress meets in Cambridge from August 16 to 23 under the presidency of Professor A. C. Seward, of the University of Cambridge. The honorary treasurer is Dr. A. B. Rendle, British Museum (Natural History), and Mr. F. T. Brooks, Botany School, Cambridge, and Dr. T. F. Chipp, Royal Botanic Gardens, Kew, are honorary secretaries.

According to the preliminary program, vice-presidents of the congress have been elected as follows:

Professor L. H. Bailey (Ithaca), Professor F. O. Bower (emeritus professor, Glasgow), Dr. J. I. Briquet (Geneva), Professor L. Buscalioni (Bologna), Professor R. H. Chodat (Geneva), Dr. L. Cockayne (Wellington, New Zealand), Professor P. A. Dangeard (Paris), Professor F. E. W. Elfving (Helsingfors), Professor H. G. A. Engler (Berlin-Dahlem), Professor Boris Fedtschenko (Leningrad), Professor Carl von Goebel (Munich), Professor V. Grégoire (Louvain), Professor R. A. Harper (New York), Professor B. Hayata (Tokyo), Professor J. Holmboe (Oslo), Professor H. O. Juel (Upsala), the President of the Linnean Society (London), Professor L. Mangin (Paris), Dr. E. D. Merrill (New York), Dr. S. G. Navashin (Moscow), Professor B. Němec (Prague), Sir David Prain (formerly director, Royal Botanic Gardens, Kew), Professor Christen Raunkiär (Copenhagen), the President of the Royal Horticultural Society (London), Professor C. Schröter (Zurich), Professor Hugo de Vries (Lunteren, Holland), Professor F. A. F. C. Went (Utrecht), Professor R. Wettstein-Westersheim (Vienna).

The presidents and vice-presidents of the sectional programs are as follows:

Bacteriology—President, Professor R. E. Buchanan, department of bacteriology, Iowa State College. *Vice-presidents*, Professor R. Burri (Liebefeld bei Bern, Switzerland), Professor H. R. Dean (Cambridge), Professor Orla Jensen (Copenhagen), Professor J. C. G. Ledingham (London), Dr. S. A. Waksman (New Brunswick, New Jersey).

Phytogeography and Ecology—President, Professor H. C. Cowles, University of Chicago. *Vice-presidents*, Professor L. Diels (Berlin-Dahlem), Professor K. Domin (Prague), Professor C. E. H. Ostenfeld (Copenhagen), Professor Pavillard (Montpellier), Dr. Ruebel (Zurich), Professor C. Skottsberg (Gothenburg), Professor W. Szafer (Cracow), Professor A. G. Tansley (Oxford).

Genetics and Cytology—President, Professor O. Rosenberg, Botanical Institute, Stockholm. *Vice-presidents*, Professor E. Baur (Müncheberg), Dr. A. F. Blakeslee (Cold Spring Harbor), Professor V. Grégoire (Louvain), Sir Daniel Hall (Merton, London), Professor H. Kihara (Kyoto), Professor B. Němec (Prague), Miss E. R. Saunders (Cambridge), Professor N. I. Vavilov (Leningrad), Professor O. Winge (Copenhagen).

Morphology (including Anatomy)—President, Professor J. C. Schoute, Groningen, Holland. *Vice-presidents*, Dr. A. Arber (Cambridge), Professor L. Buscalioni (Bologna), Professor C. J. Chamberlain (Chicago), Professor F. E. Fritch (London), Professor C. M. H. Glück (Heidelberg), Professor E. Küster (Giessen), Professor W. H. Lang (Manchester), Professor N. E. Svedelius (Upsala).

Mycology and Plant Pathology—President, Professor L. R. Jones, University of Wisconsin. *Vice-presidents*, Dr. O. Appel (Berlin-Dahlem), Professor A. H. R. Buller (Winnipeg), Dr. E. J. Butler (Kew), Dr. A. Jaczewski (Leningrad), Dr. R. Maire (Algiers).

Plant Physiology—President, Dr. F. F. Blackmann, Botany School, Cambridge. *Vice-presidents*, Dr. W. L. Balls (Cairo), Professor P. Boysen Jensen (Copenhagen), Professor V. H. Blackman (London), Professor E. Demoussy (Paris), Professor H. H. Dixon (Dublin), Professor L. Jost (Heidelberg), Professor M. Korczewski (Warsaw), Professor Lepeschkin (Tucson), Professor B. E. Livingston (Baltimore), Professor F. E. Lloyd (Montreal), Professor H. Lundegårdh (Stockholm), Professor N. Maximov (Leningrad), Professor W. J. V. Osterhout (New York), Professor W. Ruhland (Leipzig), Professor A. Ursprung (Fribourg, Switzerland), Professor F. A. F. C. Went (Utrecht).

Paleobotany—President, Dr. D. H. Scott, East Oakley House, Basingstoke, England. *Vice-presidents*, Professor E. W. Berry (Baltimore), Professor P. Bertrand (Lille), Professor W. Gothan (Berlin), Professor T. G. Halle (Stockholm), Dr. W. J. Jongmans (Heerlen), Professor Kraüsel (Frankfurt), Professor A. Renier (Brussels), Professor B. Sahni (Lucknow), Dr. G. R. Wieland (New Haven).

Taxonomy and Nomenclature—President, Professor Dr. L. Diels, Botanischer Garten und Botanisches Museum, Berlin-Dahlem. *Vice-presidents*, Dr. N. L. Brit-

ton (New York), Dr. E. De Wildeman (Brussels), Dr. R. E. Fries (Stockholm), Professor B. Hayata (Tokyo), Dr. A. W. Hill (Kew), Professor H. Lecomte (Paris), Dr. E. D. Merrill (New York), Professor R. Pampanini (Florence), Professor Hans Schinz (Zurich), Dr. O. Stapf (Kew), Professor R. Wettstein-Westersheim (Vienna).

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE draft of the program for the meeting of the British Association at Bristol from September 3 to 10 has now been completed and is summarized in the London *Times*. There will again be some 300 papers. The botanical section's addresses are unusually numerous, but the president this year is Professor F. O. Bower, emeritus professor of botany in the University of Glasgow. A number of the delegates to the International Congress of Botanists at Cambridge will go on afterwards to this meeting.

The president's address this year will also follow the modern rather than the older style. The model which passed in review the advancement made in every department of science will not be adopted by Professor Bower. His address will be purely botanical and will consist largely of a statement concerning his own work, and his subject will be "Size and Form in Plants."

It is interesting to note, according to the *Times*, that at a meeting in Bristol in 1898 Sir William Crookes prophesied a world-scarcity of wheat unless agriculture sought the aid of chemistry. This year one of the subjects of the agricultural section will be the relation of nitrogen to our food supply.

A meeting in Bristol is also a natural stimulus to the archeological, geological and engineering interests. There will be lectures on Roman remains in Gloucestershire and on geological formations such as those at Cheddar. Modern engineering has an important representative in the Bristol Aeroplane Company. There will be papers on recent progress in air-cooled aero-engine development and on the present position of the high-speed heavy oil engine. The latter will be associated with another lecture, by Lieutenant-Colonel V. O. Richmond, the designer of the airship R 101, which is driven by heavy oil engines. There will also be lectures on the construction of R 100 by Mr. B. N. Wallis and on the Graf Zeppelin by Herr W. E. Doerr, and films of all three airships will be shown.

Much attention will be given by the section of mathematical and physical sciences to wireless problems. A discussion on the meteorological relations of atmospherics will be shared by Dr. R. A. Watson-Watt, Professor E. V. Appleton and Mr. M. A. Giblett. Professor Appleton will also read a paper on wireless echoes and wireless demonstrations will be given by the B.B.C. Town-planning will be fully discussed by the geography section and the position of the British dyestuffs industry will be discussed in the chemistry section by Professor G. T. Morgan, Sir William Pope, Professor J. F. Thorpe, Professor A. G. Green and others.

The public lectures will be more numerous than usual. Bath, Cheltenham, Gloucester, Devizes and Chard, for instance, have all asked for lectures on economic subjects. Sir Josiah Stamp will lecture at Bath on the price level and scientific control. Weston-super-Mare, having chosen a health subject, will hear Professor Winifred Cullis on "Breathing under Difficulties"; Swindon will have a lecture on some branch of aeroplane engineering by Wing Commander Cave-Brown-Cave, and Cirencester will have a description of Gloucestershire excavations by Dr. R. E. Mortimer Wheeler.

One of the subjects for Bristol is the bearing of research on the improved production of apples. Sir Daniel Hall will give this lecture on market day. Sir Arthur Keith will speak on the contribution of Dr. John Beddoe, the Bristol anthropologist, to modern anthropology. East African archeology and astronomy will be the other subjects at Bristol.

The centenary meeting of the British Association will be held next year in London, probably with General Smuts as president. It will take place at the end instead of the beginning of September, and its chief meetings will probably be held at the Central Hall, Westminster.

SCIENTIFIC NOTES AND NEWS

THE eightieth birthday of Dr. William H. Welch was celebrated in the Kitasato Institute for Infectious Diseases in Tokyo on April 8. The main address was made by Dr. Kitajima; other speakers were Dr. Madsen, of Copenhagen; Professor Kofoid, of the University of California, and Dr. Kitasato.

A DINNER was recently given in London by the Physiological Society in honor of the eightieth birthday of Sir Edward Sharpey-Schafer, professor of physiology at the University of Edinburgh.

IN honor of Dr. George F. Arps, professor of psychology and dean of the College of Education of the Ohio State University, a dinner was given on the tenth anniversary of his deanship. Dr. W. O. Thompson, president emeritus; Julius F. Stone, chairman of

the board of trustees; Dr. Boyd H. Bode, and Professor Wilbur H. Siebert paid tribute to him.

AT a recent meeting of the council of the French Society of Industrial Chemistry, Professor Marston Taylor Bogert, of Columbia University, was elected to honorary membership.

PROFESSOR SIGMUND FREUD, psychiatrist, of Vienna, has been awarded the Goethe prize for scientific and literary distinction.

SIR CHARLES SHERRINGTON, Waynflete professor of physiology in the University of Oxford, and Dr. J. A. Arkwright, honorary bacteriologist to the Lister Institute of Preventive Medicine, have been appointed members of the British Medical Research Council in succession to Sir Frederick Hopkins and Sir Charles Martin.

DR. HUGH P. BAKER, who served as the first dean of the New York State College of Forestry at Syracuse University from 1912 to 1920, has been re-elected to that office by the board of trustees. He succeeds the late Dean Franklin Moon. Dr. Baker left Syracuse University to accept a position as executive secretary of the American Paper and Pulp Association. Two years ago he became manager of the department of trade association service in the U. S. Chamber of Commerce. Before going to Syracuse the first time he was head of the departments of forestry of the Pennsylvania State College and of the Iowa State College. Professor Nelson C. Brown, acting dean of the college since Dr. Moon's death, was given a vote of appreciation for his service by the trustees. He will remain in the college in an administrative capacity.

DR. ALLAN WILSON HOBBS, professor of applied mathematics and a member of the faculty for thirteen years, has been appointed dean of the College of Liberal Arts of the University of North Carolina, succeeding Dr. Addison Hibbard, who resigned in May to accept a position at Northwestern University.

UNDER the Bosch benefaction at Sydney University the following appointments have been made: to the chair of surgery, Dr. Harold Dew, practicing surgeon of Melbourne; to the chair of bacteriology, Dr. Hedley Duncan Wright, reader in bacteriology in the University of London and assistant editor of the *Journal of Pathology and Bacteriology*, and to the chair of medicine, Dr. Charles George Lambie, lecturer in medicine at the University of Edinburgh.

DEAN ROSCOE POUND, of the Harvard Law School, has been nominated by the British group for judge of the Permanent Court of Arbitration. The Australian group also nominated Dean Pound to fill the unexpired term of Mr. Charles Evans Hughes.

THE Secretary of State for Scotland has appointed Mr. A. Froude to be registrar-general for Scotland, in succession to Dr. James Craufurd Dunlop, whose retirement under the age limit will take effect on September 3.

THE American Engineering Council has announced the appointment of six engineers to an advisory committee which, under Dr. George K. Burgess, director of the United States Bureau of Standards, will plan the design and equipment of the National Hydraulic Research Laboratory. Two members of the committee—John R. Freeman, of Providence, and William B. Gregory, professor of experimental engineering at Tulane University—will devote several months to the study of hydraulic laboratories in Europe. The other members of the advisory committee are Sherman M. Woodward, professor of mechanics and hydraulics at the University of Iowa; Lewis F. Moody, consulting engineer for Cramp-Morris Industrials, Inc.; Ely C. Hutchinson, editor of *Power*, and Blake R. Vanleer, assistant secretary of the American Engineering Council.

THE National Tuberculosis Association announces the appointment of three research fellows for the academic year 1930–31. The successful candidates were selected from a large number applying from all parts of the country. Those to whom the awards were made are: Alvin E. Belden, M.D., Lancaster, Pennsylvania; William F. Lawrence, C.P.H., Portsmouth, Virginia, and Edna E. Nicholson, A.B., Ann Arbor, Michigan.

THE trustees of the Ramsay Memorial Fellowships have made the following awards of new fellowships for the session 1930–31: Mr. W. R. Angus, a fellowship of £300, tenable for two years, at University College, London; Dr. K. Krishnamurti, a fellowship of £300, tenable for one year, at University College, London; Dr. James Bell, a Glasgow fellowship of £300, tenable for two years, at University College, London, and Dr. A. Girardet, a Swiss fellowship of £300, tenable for one year, at the University of Edinburgh. The trustees have renewed the following fellowships for the same session: Dr. H. Erdtman (Swedish fellow), University College, London; Dr. A. Klinkenberg (Netherland fellow), University of Cambridge; Professor Y. Nagai (Japanese fellow), University College, London, and Dr. Lloyd M. Pidgeon (Canadian fellow), University of Oxford.

THE trustees of the Beit Fellowships for Scientific Research, founded and endowed in 1913 by Sir Otto Beit, have awarded fellowships, tenable at the Imperial College of Science and Technology, South Kensington, for the two years 1930–32, of the value of £250 a year each, to Mr. Bernard William Brad-

ford, for research upon the electrical condition of hot metallic surfaces when promoting the combustion of carbonic oxide; to Mr. George Maxwell Richardson, for research into the further application of electrometric methods and theory to the study of problems of biological interest, and to Mr. Geoffrey Herbert Cheesman, for research on the electron distribution and structure of the halogen oxides.

DR. GEORGE GRANT MACCURDY, of Yale University, honorary collaborator in the anthropological department of the U. S. National Museum, has been appointed American delegate to the eleventh International Congress of Prehistoric Anthropology and Archeology at Coimba, Portugal. Dr. MacCurdy will also be the American delegate to the fourth session of the International Institute of Anthropology meeting simultaneously at Coimba.

DR. A. S. HITCHCOCK sailed for Europe on August 1 to attend the International Botanical Congress at Cambridge. He attends the congress as delegate from the U. S. Department of Agriculture, the Botanical Society of America and the Botanical Society of Washington.

DR. C. J. WIGGERS represented Western Reserve University at the medical meetings connected with the recent celebration of the one hundredth anniversary of Belgian independence in Brussels.

MR. RUDYARD BOULTON, assistant curator of ornithology at the Carnegie Museum of Pittsburgh, an expert in the collection and preservation of insects, and Mrs. Boulton, sailed on August 5 for England. They will accompany Mr. and Mrs. Ralph Pulitzer in an expedition to southeastern Angola, Africa and down the Okavango River, where it is hoped to find specimens of the white rhinoceros. The specimens collected by the expedition will go to the Carnegie Museum.

THE Scarritt Patagonian expedition to collect fossil mammals under the leadership of Dr. George Gaylord Simpson, of the staff of the American Museum of Natural History, sailed for Buenos Aires on August 8.

DR. CLYDE FISHER, of the American Museum of Natural History, has visited Iceland on a mission for the New York Bird and Tree Club, of which he is president. He will also visit Norway, Denmark and Sweden, where he expects to take photographs for the educational work of the museum. Dr. Fisher took with him as a gift from the New York Bird and Tree Club to the people of Iceland several crates of small American evergreen trees, as well as the promise of seedlings to be sent in the coming fall and spring. These were presented at the millennial celebration of the founding of the government of Iceland.

Natural History reports that Dr. James P. Chapin, associate curator of birds of the eastern hemisphere at the American Museum, is now on a collecting trip in the Belgian Congo, which is made possible through a fund established by Mrs. Dwight Arven Jones. Dr. Chapin attended the seventh International Ornithological Congress at Amsterdam with Dr. Frank M. Chapman, and from there went to Brussels to complete arrangements for his journey to the Belgian Congo. Dr. Chapin is accompanied by Franklin Edson, 3d, a representative of the department of mammalogy at the American Museum, who had volunteered to assist him. The material collected will make possible a group showing the bird life of an African tropical forest and will be a companion group to one depicting the bird life of the plains.

A SERIES of Hertzein lectures was given under the auspices of the University of California and Stanford University in San Francisco on August 7, 8 and 9, by Dr. Charles Singer, of the University of London. The titles of the separate lectures were: "Medieval and Modern Medicine" Part I and Part II, and "The Scientific Works of Leonardo da Vinci."

THE annual meeting of the American Astronomical Society will be held in Chicago from September 3 to 5.

THE fourth International Congress for Individual Psychology will be held in Berlin from September 25 to 28. It will open with an address by Dr. Alfred Adler.

THE thirteenth International Congress of Hydrology, Climatology and Medical Geology will be held at Lisbon from October 15 to 23. During the congress visits will be paid to the more important towns and spas of Portugal, and an excursion will be made to the Azores and Madeira. Further information can be obtained from the Faculty of Medicine, Lisbon.

THE council of the Royal Institute of Public Health of Great Britain has accepted an invitation from the German Government, the municipality of the city of Frankfurt and the university of that city to hold its congress in May, 1931, in Frankfurt. The Marquess of Reading will preside.

IT is reported in *Nature* that the fifth ordinary general meeting of the Ross Institute and Hospital for Tropical Diseases was held on July 9. The Chairman, Sir Charles McLeod, reviewed the work of the year. Sir Ronald Ross, Sir William Simpson, Sir Aldo Castellani and D. Shaw-Mackenzie have continued their researches, and a new department in charge of Sir Malcolm Watson has been created to deal with malaria and its problems. Short courses for planters on malaria control have been held and much propaganda work on this subject has been prosecuted.

The institute has no endowment fund except a few hundred pounds and is dependent for its income upon contributions from companies and donations and subscriptions, an increase in which is appealed for.

BECAUSE of a year's delay in obtaining radium for the Marie Curie Radium Institute of Warsaw, for which Mme. Curie was given $50,000 in 1929 by a group of Americans, the hospital will not be able to open its doors until December. The delay is said to have had its advantages, however, for the interest on the money will be sufficient to purchase platinum screens for the radium when it becomes available.

MAJOR-GENERAL MERRITTE W. IRELAND, Medical Corps, U. S. Army, states that the "Index Catalogue of the Surgeon General's Library" is to be continued, after consideration of replies to his recent letter of inquiry. Ninety per cent. of institutions and organizations addressed expressed an earnest desire for a continuation of the catalogue. A new series will be started after the completion of the present, or third, series.

AN Associated Press dispatch reports that Premier Mussolini, on receiving plans for the dental clinic for which Mr. George Eastman, of Rochester, N. Y., gave $1,000,000, ordered the opening for October 28, 1932, the tenth anniversary of the Fascist march on Rome.

CHRISTIAN MICHELSEN, formerly prime minister of Norway, has instituted a fund of 5,500,000 crowns for scientific research. The statutes of the institute to which the funds are to be given contain a provision to the effect that the board may grant yearly contributions to Norwegians interested in research work.

A DECISION was handed down by the Court of Claims on June 16, 1930, in a test suit brought by the Cosmos Club, Washington, which holds that it is not a social, sporting or athletic club within the meaning of the Internal Revenue Act providing for taxes on dues and initiation fees of members of a social, sporting or athletic club and that therefore the ten per cent. tax on dues and initiation fees of members which heretofore has been exacted should be returned by the government.

A DECISION resulting from the refusal of Harvard University to accept a gift in a will to endow courses for instruction in eugenics has been handed down by the Supreme Court of Pennsylvania in the cases of Mears' Estate, in which the court held that the gift was one which must be deemed to be for a charitable use, and that since the specific purpose had failed because of Harvard's rejection of the gift, the court would name another medical school to carry out the charitable intent of the testator.

DISCUSSION

EARLY DEFINITIONS OF THE MATHEMATICAL TERM ABSTRACT GROUP

WHILE science is international it is always of some interest to consider the question in what country certain fundamental ideas were first published. For instance, it is well known that English and German writers were inclined for many years to claim for their own respective countries the discovery of the calculus under the leadership of I. Newton and G. W. Leibnitz, respectively. Hence it is of some interest to note here that the honor of the discovery of abstract group theory seems also to be shared by these two countries, although up to the present time it has been customary to credit German writers alone, especially L. Kronecker (1870) and H. Weber (1882 and 1893), for the earliest publications of sets of postulates relating to abstract groups. Sometimes G. Frobenius (1887) has also been thus credited.

This credit entails, however, a striking anomaly in the history of group theory since it is universally admitted that the English writer A. Cayley was the first to publish a complete determination of the possible abstract groups of all the orders which do not exceed certain small numbers, publishing this determination for the orders less than 8 in 1854 and for order 8 in 1859. It is obviously impossible to determine rigorously all the abstract groups of a given order without employing a definition of the technical term abstract group, and such a definition implies a set of postulates. What is perhaps a still more striking anomaly in the history of group theory is the fact that A. Cayley is commonly given credit for the earliest proof (1854) of the fundamental theorem that every abstract group of finite order can be represented as a regular substitution group, and such a proof seems to imply a set of group postulates.

This proof results directly from the well-known group table which was used by A. Cayley in 1854, and hence it seems to imply that a set of group postulates was known in England at that time. As a matter of fact it is not difficult to see that A. Cayley used here substantially the same set of postulates for a finite group as the one which was published later by H. Weber in the *Mathematische Annalen*, volume 20 (1882), page 302. It is true that A. Cayley's postulates were not as clearly formulated as some of those which were published later and that he restricted his attention to groups of finite order. On the other hand, the set of postulates which was published by L. Kronecker in 1870 and which has been widely quoted

as the earliest set of abstract group postulates is not only restricted to groups of finite order but also to commutative groups of such orders.

One of the most fundamental postulates relating to group theory is that the elements of a group must obey the associative law but not necessarily the commutative law when they are combined. This postulate is explicitly stated in the usual form by A. Cayley in the article under consideration. The postulate that the product of two elements of a group is equal to an element thereof is also stated here in the usual form. As a third postulate A. Cayley assumes here that if $axb = ayb$, where a and b are two elements of the group, then $x = y$ if one of them is an element of the group. As he assumed that every integral power of each element of the group is in the group he could readily prove that the identity is also therein, and hence a group postulate commonly given now results from his third postulate noted above by letting a and b represent successively the identity.

The main object of the present note is to exhibit some of the reasons for saying that the earliest set of group postulates was due to A. Cayley and thus to make the historical statements relating to the early developments of abstract group theory appear more harmonious. It is commonly said that the earliest treatise on abstract group theory is the "Theory of Groups of Finite Order," by W. Burnside, 1897. This would seem to imply that as far as group theory is concerned the tendency towards the abstract was more marked in England than in the other European countries. At any rate, it is interesting to note that notwithstanding the great importance of the groups of infinite order the earliest definitions of abstract groups both in England and in continental Europe were restricted to groups of finite order.

It may be desirable to add to the above a brief explanation of the technical term abstract group. This term implies not only that no attention is paid to the applications in the theory of these groups but also that no properties of their elements are considered therein except those relating to the laws which these elements obey when they are combined. Such a group can therefore not exist without its corresponding set of postulates. It is interesting to note that while a large number of different sets of postulates has been proposed these sets have nearly always been equivalent and differed from each other only as regards simplicity or redundancy. Hence no serious diversity in developments has as yet arisen on account of the adoption of different definitions of the term group. It is true that the term group is also sometimes used in the mathematical literature with such a general meaning that no extensive theory can as yet be based thereon. This is done, for instance, in the *Encyclopédie des Sciences Mathématiques,* tome 1, volume 2, page 243. The preceding remarks have obviously no contact with this definition.

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SELENITE FRAGMENTS OR CRYSTALS AS CRITERIA OF WIND ACTION

STUDENTS of geomorphology are naturally interested in and seeking for criteria which may be used to interpret the origin and history of land forms. Various criteria of wind action have been and are now being used by students of geomorphology to establish the effectiveness of the wind as the chief agent in producing and destroying the land forms of arid regions. Among such criteria may be mentioned the following: wind-worn stones, collar-studs, vermicular or arabesque limestones, stone lace, stone lattice, lag gravels or desert pavements, pedestal rocks, niches and caverns, jardang or sphinx rocks, dunes, ridge and hollow type of topography, depressions or lake basins, etc. It is not the purpose of this short paper to discuss the merits of these phenomena as criteria of wind action, but it is sufficient to say that some of them, such as pedestal rocks, niches, vermicular limestones, stone lace and stone lattice, have lost much of their critical value as a result of detailed studies.[1]

Experiments performed by Schoewe at Harvard University last winter on the formation of dreikanter or ventifacts by means of an artificial sandblast have suggested a new criterion which may be used to indicate the presence or absence of wind action. In the course of these experiments, several substances were introduced into the sandblast for the purpose of studying the rate and also the general effect of abrasion by sand. Bright, glistening cleavage fragments of selenite were immediately frosted. The effect took place so rapidly that it is inconceivable that bright selenite fragments could exist in an area having any effective action by windblown sand. In arid regions the optimum condition obviously exists for the formation, preservation and accumulation of selenite crystals or cleavage fragments at the surface.

Gypsum is soluble in rain water, as noted by Lahee,[2] who proved that granular gypsum was dissolved at the rate of one inch (25.4 mm) in twenty-eight years in Stonewall County, Texas, where the rainfall is twenty-three inches (584.2 mm) a year.

[1] Kirk Bryan, "Pedestal Rocks in the Arid Southwest," U. S. Geol. Survey, Bull. 760, 1923, pp. 1–11; "Pedestal Rocks in Stream Channels," U. S. Geol. Survey, Bull. 760, 1923, pp. 123–128; "Pedestal Rocks Formed by Differential Erosion," U. S. Geol. Survey, Bull. 790, 1926, pp. 1–19; "Niches and Other Cavities in Sandstone at Chaco Canyon, New Mexico," *Zeitschr. f. Geomorphologie,* 3: 125–140, 1928; B. G. Esher, "Über des Reliefs auf den sogenannten Rillensteinen," *Geol. Rundschau,* 4: 1–7, 1913.

[2] F. H. Lahee, "The Rate of Solution of Gypsum," *Jour. Geol.,* 33: 548–549, 1925.

Most areas in the United States characterized by selenite fragments have annual rainfalls of from five to fifteen inches (125 to 375 mm). Obviously none of the fragments can lie on the surface for any great number of years and still remain bright and glistening, since they will be gradually dulled by solution. Even this short time is long compared to the few minutes necessary for frosting by the sandblast.

Hence it is safe to conclude that bright, glistening fragments or crystals signify an absence of effective wind action. The presence of these fragments of selenite in the vicinity of niches and pedestal rocks, such as occur at so many localities in the Cretaceous, Jurassic and Triassic areas of Western United States, might be used as indicative of the general absence of effective wind scour.

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ARE PLANETS RARE?

THE latest statement of Professor Arthur H. Compton as reported in the *Literary Digest* under the title, "Science's New View of Evolution," should not be allowed to pass without comment.

That a directive intelligence is evident in the universe is undoubtedly held by a great majority of scientists; but that the new principle of uncertainty "which disputes the uniformity of the physical world" supports this view many of us might be disposed to question. The unity of the universe, as shown by the absolute unchangeableness of natural law, has been held from the time of Newton to be one of the strongest arguments for the existence of God.

Leaving this aside, however, I seriously question Professor Compton's statement in regard to the rare occurrence of planets. He says, "Though astronomers tell us that there are millions of millions of stars in the sky, a planet is a very rare occurrence, and a planet on which life can exist is even more rare."

No telescope, unfortunately, will show us the planets of other suns. Our views on the subject must be based on what we find in our own system. Here we have eight major planets revolving about the sun, and six of these have satellites forming miniature solar systems. Does this look as though such systems were a freak of nature—a rare occurrence? That double stars have planetary systems may be doubtful, but there is absolutely no reason for the assumption that the formation of families of attendant worlds may not be the ordinary course of evolution for the single stars.

As for life on these worlds, we have in our system one out of eight that is fitted for the support of life, and another, Venus, which may be habitable. Why should the proportion be different throughout the universe? Surely the success of the noble experiment of life on the earth has not been so notable that we may not hope for better results elsewhere.

JERMAIN G. PORTER
THE CINCINNATI OBSERVATORY

VIABILITY IN EGGS OF AEDES CAMPESTRIS DYAR AND KNAB (CULICIDAE)

ON July 12, 1928, adults of *Aedes campestris* were caught as they came to feed, allowed to engorge and then isolated over water. Four days later eggs were laid. These were placed in pond water in tightly stoppered glass vials and stored in a cold chamber in which the temperature fluctuated between 0° and 10° C. In March, 1930—twenty months after they were laid—the vials were unstoppered and placed at 22° C. Within twelve hours about 25 per cent. of the eggs hatched, and during the ensuing five days several additional eggs hatched into healthy, vigorous larvae, which duly matured.

Aedes campestris constitutes one of the dominant species in the plains areas in Montana, and this remarkable viability of the eggs merely complicates the problem of efficient control.

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THE MITOSIS FOUND IN HYDRA

THE endoderm and ectoderm of hydra each present epitheliomuscular and interstitial cells. The mitosis occurring in epitheliomuscular cells is quite typical for a dividing metazoon cell. The interstitial cells, however, present a mitosis that is more primitive. The mitotic figure of an interstitial cell lacks asters, centrosomes and centrioles, despite the fact that spindle fibers converge sharply at the poles. Moreover, the primitive condition of the mitosis of the interstitial cell is seen in the fact that the prophases appear within the original nuclear area. A marked characteristic of the mitosis of the interstitial cells is that its spindle fibers persist even after the daughter nuclear membranes have been formed. The daughter cells themselves are linked together by a persistent spindle. This vestigial spindle eventually disappears and the daughter interstitial cells lie contiguous but free.

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SCIENTIFIC BOOKS

Four Centuries of Medical History in Canada, and a Sketch of the Medical History of Newfoundland. By JOHN J. HEAGERTY, M.D., D.P.H., with a preface by A. G. Doughty, C.M.G., F.R.S.C. 2 vols. 8°. Toronto, Macmillan Co. of Canada, Ltd., 1928.

As the Dominion archivist points out in his preface, the outstanding merit of this work is that the author, wherever possible, "allows contemporaries to tell their stories for themselves." It is a thoroughly documented history, based primarily upon findings in the Public Archives of Quebec, Ottawa and Montreal; while Jacques Cartier, Champlain and the Jesuit fathers tell, in their own language, of the effects of smallpox, yellow fever, plague, typhus fever, leprosy, cholera, influenza and other devastating diseases upon the immigrant population. For this purpose, the Canadian records are singularly complete, from the *Jesuit Records* and those of the sixteenth century explorers, down to the latest government documents. Although the author has modestly aimed to produce a reference work rather than a continuous story, his opening chapters on the outstanding diseases affecting the infant colony make very good reading, of particular value to the historian of the future. For it is just the effect of disease upon the course of history which has been most neglected by secular historians. Both Thucydides and Lucretius stress the social significance of the plague of Athens and Livy the effects of epidemic diseases upon Roman military campaigns; but the subject is ignored by Wells, nor does it receive any attention in the 20 large volumes of the "Cambridge History, Ancient and Modern." Dr. Heagerty's opening chapters show that communicable diseases kept down the immigrant population of the New World as effectively as in the older countries of sixteenth century Europe. His documentation of the theme is as thoroughgoing as that of Creighton ("History of Epidemics in Britain") and is a model for all future historians of medical developments in individual countries or nations. As Gjerset and Hektoen found in the Wisconsin records, the successive shiploads of immigrants were as a thin red line on the edge of battle until the arrival of a sufficient number of *bona fide* physicians to look after them. The pioneer physicians in the various provinces of Canada form the subject-matter of Part 2 of the first volume.

Of these Deschamps, Maître Estienne, Daniel Hay, Louis Hébert, Bonnerme, Duchesne, André Daniel, Robert Giffard, René Goupil, Jean Madry, Jourdain Lajus, Thimothée Roussel, Michael Sarrazin, the leading surgeon of seventeenth century Canada, and J. F. Gualthier, discoverer of the wintergreen plant (*Gaultheria procumbens*), are notable in the early history of Quebec; John Gilchrist, James MacAulay, Christopher Widmer, Grant Powell, John Rolph, William Dunlop in Ontario; Abraham Gesner in Nova Scotia; Roderick MacDonald and Benjamin de St. Croix in Prince Edward Island; Desmarets, Curtis Bird and Sir John Schultz in the North West Territories; Tolmie and Helmcken in British Columbia; Jonathan Ogden, Francis Bradshaw and William Carson in Newfoundland.

The names of 22 French surgeons and apothecaries are found in the Quebec registers of 1629–63 and Heagerty lists the names of 42 French physicians practicing in Montreal during 1648–1760. As Carlyle said, Frederick's campaigns decided incidentally whether the upper half of the Western hemisphere was to be French or Anglo-Saxon. The first volume winds up with chapters on the earlier status of medical and surgical practice in Canada, the medical journals, the medical societies, the beginnings of military medicine and the development of public health departments in the different provinces. Bleeding, purging and sweating constituted the staples of medical practice; diphtheria was continuously epidemic up to the introduction of antitoxin (1894) and surgery was primitive prior to the discoveries of anesthesia (1847) and antisepsis (1867–77). Specialism began when Dr. Richard Andrews Reeve commenced practice in ophthalmology and otology in Toronto (1867). The first medical periodicals were the *Journal de médecine de Quebec* (January, 1826) and the *Montreal Medical Gazette* (1845). The first medical society was the Quebec Medical Society (1826). The earliest known Canadian medical publication is the *Direction pour la guérison du mal de la Baie St. Paul* (Quebec, 1785), a 16-page pamphlet in the Library of the Provincial Archives of Quebec.

The second volume is taken up with such public health developments as prevention of tuberculosis, nursing orders, Red Cross, mental and social hygiene, the Grenfell Mission, quarantine, vital statistics, legislation, with terminal chapters on the medical schools and hospitals. The first public health laws of Quebec were enacted in 1707. The first hospital was the Hôtel Dieu of Quebec (1639). Montreal General Hospital was founded in 1818, and around it grew up the earliest establishment for medical education, the Medical Faculty of McGill University (1822), the story of which has been told at length by Maude Abbott (1902). The first provision for organized care of the insane was the establishment of an asylum in a manor-house at Beaufort (1845). An appendix on the history of medicine in Newfoundland, an extensive bibliography and an index of contents close the work, which is profusely illustrated.

F. H. GARRISON
WELCH MEDICAL LIBRARY, BALTIMORE

SOCIETIES AND MEETINGS

THE ILLINOIS ACADEMY OF SCIENCE

THE Illinois Academy of Science held its twenty-third annual meeting at the University of Illinois at Urbana on May 2 and 3, 1930. The meeting was held in conjunction with the quarter-centennial celebration of the Illinois State Geological Survey, and was the best attended in the history of the organization. Over 600 were present at the various sectional meetings. As the result of an intensive membership campaign, about 250 new members were added, bringing the total membership to nearly 1,000. These new memberships include 23 new high-school science clubs which have become affiliated with the state organization.

At the business sessions of the academy a decision was reached to create a Hall of Fame for Illinois scientists. The committee selected to take charge of this project includes five members, all of whom are past presidents of the academy: Dr. M. M. Leighton, chief of the State Geological Survey, *chairman;* Dr. William A. Noyes, professor emeritus of chemistry, University of Illinois; Dr. H. J. Van Cleave, professor of zoology, University of Illinois; Dr. Henry C. Cowles, chairman of the department of botany, University of Chicago, and Dr. U. S. Grant, chairman of the department of geology, Northwestern University.

Other officers and committees elected to serve for 1930–1931 are as follows:

President, Fred R. Jelliff, the *Daily Register-Mail*, Galesburg.

First vice-president, William P. Hayes, University of Illinois.

Second vice-president, Arthur L. Epstein, Peoria.

Secretary, F. M. Fryxell, Augustana College.

Treasurer, George D. Fuller, University of Chicago.

Librarian, A. R. Crook, State Museum, Springfield.

Delegate to the American Association for the Advancement of Science, A. C. Walton, Knox College.

Delegates to the Conservation Council of Chicago, W. G. Waterman, Northwestern University, Evanston; V. O. Graham, University of Chicago.

F. M. FRYXELL,
Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A RAPID METHOD FOR STAINING SECTIONS OF THE SPINAL CORD AND BRAIN-STEM

SECTIONS used for class teaching of the central nervous system are commonly prepared by rather elaborate and time-consuming technique, even so-called rapid methods being relatively complicated.

In searching for a substitute to supply each student with a complete series to assure him a chance to examine every important feature, the writer found an exceptionally quick method of procedure, with the added advantage over the more complicated techniques that it furnishes a remarkably ready and direct correlation between gross and microscopic structure, and makes complete series unnecessary, though of course these are not superseded entirely.

Using this method students can select pieces of the cord or brain-stem which have been hardened a few days or longer, or which come from the cadaver, and cut through any desired region with a safety razor blade, to show in a few minutes the microscopic details of the parts cut. Thus one secures the readiest comparison and understanding of the buried microscopic structures and connections forming the basis of surface relief. This is one of the difficult problems of beginners, and it is most helpful for them to be able to repeat such studies, at will, through different levels.

Naturally the material of a dissecting room varies, and the sharpest pictures will come from the best fixed bodies; but there are advantages in having pathological conditions shown in some sections. It is also valuable to be able to demonstrate the results of specific lesions, as ascending or descending degeneration of various tracts, in subjects which have been examined for other correlated pathology.

To lay open, at will, and demonstrate quickly the finer internal relations of nuclei and connections of any cranial nerve or other special structure of the medulla prominent in surface views is a helpful preliminary to later more detailed study by other methods.

The method can be also used in testing conclusions gathered from symptoms and autopsy, without loss of time and sacrifice of material, since it marks out degenerate posterior funiculi or crossed and direct cerebrospinal tracts or other pathological features. I have not investigated this phase extensively beyond making tests of the practicability of such diagnosis. For the opportunity of making these tests on cords with known histories I have to thank Dr. N. W. Winkleman, of the department of neurology in the Medical School of the University of Pennsylvania.

The method here outlined is an adaptation of the "Rapid Iron Hematoxylin Technique" which was published by Dr. E. C. Cole, of Williams College, in

SCIENCE, November 5, 1926.[1] My own modifications of the technique are in connection with the special material used and the exceptional use of quite thick sections, together with the study of these in a strong reflected surface light, rather than by transmitted light from below through cleared sections. For special purposes it is possible of course to stain relatively thin frozen sections by this technique, and clear and study as usual, but the quicker method with thick sections seems preferable for the objects of this study.

The following steps of procedure are recommended.

(1) Material: Pieces of cord and brain-stem from cadavera in which formalin has been introduced beneath the dura and allowed to stand are most favorable. Some specimens which were evidently embalmed late showed fatty degeneration more or less markedly. Pieces of cord which have remained *in situ* during the dissection of the body can be removed to alcohol and put through this method from 95 per cent. alcohol. Fresh cords make excellent material after thorough hardening, poorly fixed and hardened specimens crumbling on cutting. Old bottled formalin or alcoholic material may often be used with good effect.

(2) Cutting: Sections should be smoothly cut freehand, one or more millimeters thick, with a sharp, flat, thin razor blade. The thicker sections are preferable, though frozen sections of about 100 micra which do not curl or tear are quite usable. As has been said, it is feasible to cut thinner frozen sections, double stain, clear and mount in balsam, but these have restricted usefulness.

(3) Mordanting: Sections should stand in 95 per cent. alcohol for at least 5 minutes, then be transferred to Cole's mordant made as follows: 50 per cent. alcohol, 20 cc; ferric chloride, 1 grm; glacial acetic acid, 2 cc. Sections remain in this mordant for at least 5 minutes. For some material this process of mordanting is sufficient when prolonged till the details of structure have developed out sharply. The sections can then be removed to alcohol and studied without further treatment, but most material gives better results when stained as follows.

(4) Staining: First prepare Cole's "stock hematoxylin solution" as follows: absolute alcohol, 20 cc; sodium hydrosulphite (same as sod. bisulfite), 0.2 grm; distilled water, 5 drops; hematoxylin crystals, 1 grm. Use light brown crystals, not dark crystals of hematoxylin. A useful discussion of the staining will be found in Dr. Cole's original article.

Now add 5 drops of this just described stock solution to 10 drops of tap-water, and follow this with 1 drop of ammonium hydroxide. Before using let this mixture stand to ripen for 30 seconds. Now add 5 cc of 95 per cent. alcohol to this ripened staining solution and flood the section (which has been taken from its alcoholic bath) to cover its smooth-cut surface. Allow the stain to act for at least 5 minutes. This over-stains and must be differentiated.

(5) Differentiation: This should be accomplished by destaining through the action of 0.4 per cent. hydrochloric acid. The microscopic details of the gray matter can be thus brought out sharply in contrast to a darker background. It is sometimes well to stroke the surface with cotton or lens paper to remove sediment deposited from the stain. When sharp definition is obtained rinse off in slightly alkaline 95 per cent. alcohol and study by strong reflected light.

A very instructive picture of the grosser features and relations of the gray figure, compared in different regions, is secured by diluting the stain and using it briefly without differentiation. In this case the gray figure and septa stand out black against the lighter matter of the funiculi, but little detail is shown within the gray figure.

Dr. Cole's original paper contains interesting discussion of the various applications and problems connected with the use of his stain which does not seem to be known as well as it deserves.

(6) Lighting: Reflected light of strong intensity should be used, preferably concentrated on the surface of the section by a condensing lens. Under this lighting the section should be studied with a hand lens, binocular spectacles or a low power 48 millimeter objective on a compound microscope.

Of course the mordant and stock solutions will be prepared in advance for class work, and each student will follow the technique in watch-glasses and begin study of the specimens in a few minutes. Once stained, sections may be kept in alcohol for later examination.

This paper was finished at the Wistar Institute. I take pleasure in here thanking the director and staff of the institute for many helpful kindnesses while I worked there as guest this winter.

HENRY McE. KNOWER

[1] SCIENCE, 64: 452–3.

CELLULOID CASES FOR MICROSCOPES, MICROTOMES AND BEAM-BALANCE CASES

BELL jars placed over microscopes are hazardous both to microscope and bell jar, because bell jars are cumbersome and heavy. A cone or cone frustum made of celluloid will answer as well, cost much less, be far more convenient and have a longer life than a glass bell jar.

Purchase a sheet of celluloid from a mail-order house or auto-supply store. Cut a sheet of stiff paper to form a cone to fit the microscope; use this as a

pattern for celluloid. For a large microscope piecing may be necessary. Use celloidin, or better, Dupont Duco Cement, permitting the first application to partly dry, apply a second layer of cement, hold in place with weights or pressures for ten minutes and the job is done. (I have such a cone fitted over a Leitz research microscope standing on a Chambers micro-dissection apparatus, all beautifully visible yet dust-proof.) A cone frustum would be better looking but slightly more difficult to make, though it is merely a matter of fitting in the top. It also would eliminate the piecing necessary for the cone.

By folding the celluloid over a wire frame to give better rigidity I have made a celluloid case to cover a Thoma-Jung microtome. Dr. E. P. Bartlett, seeing this, conceived the idea of making dust-proof cases for beam balances. These are folded and cemented like paper boxes.

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DEVELOPMENT OF A PERMANENT BLUE COLOR FOR COLORIMETRIC PHOSPHORUS DETERMINATION

THE blue color used as a standard for Dénigès colorimetric method for the determination of phosphorus is very unstable. The color fades rapidly and a new color standard must be prepared rather frequently. By reducing a solution containing 2.5 grams of ammonium molybdate in 100 cc of 10 n. sulfuric acid a permanent blue color can be developed. The solution is reduced by stannous chloride. A dense blue color is formed which can be diluted to the desired intensity by adding 10 n. sulfuric acid. With proper dilutions a series of standards can be prepared which represent definite readings of phosphorus in parts per million.

The blue color developed under the latter condition is of a slightly different hue from the color of the reduced standard phosphorus solution but this slight difference in color is not enough to be objectionable. As a matter of fact, this permanent blue color compares as well to the unknown blue color as to the blue standard phosphate color.

The shades of blue color vary with the higher concentration of both ammonium molybdate and sulfuric acid. With the mentioned amount of ammonium molybdate in a slightly lower concentration than of 10 n. sulfuric acid a bright yellow color is produced upon reduction.

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SPECIAL ARTICLES

AN EFFECT OF SHORT ELECTRIC WAVES ON DIPHTHERIA TOXIN INDEPENDENT OF THE HEAT FACTOR

ABOUT thirty-five years ago D'Arsonval and Charrin found that high frequency currents of 200,000 cycles per second diminished the strength of diphtheria toxin. This effect was obtained without elevation of temperature to a level which would by itself affect the toxin. Since that time little has been done to develop this finding. Recent advances in short wave technique have given new impetus to the study of the biological action of these waves. It is readily accepted from many recent papers that such electrical waves may produce tremendous changes through the indirect medium of temperature elevation. Before any result is ascribed to the specific action of short electric waves, heat effect through conductivity and eddy currents must be ruled out. The chief import of this paper is to show that radiation of the type used here is capable of producing changes in biological substances independent of a heat effect.

Throughout, the wave-length was 1.9 meters and the substances to be radiated were placed between two condenser plates of a resonating circuit. The amperage in the resonating circuit was .95 to 1.2, and the frequency was 158,000,000 cycles per second.

From the beginning, and so far in this work—eliminating heat effect—completely negative results were obtained in attempts to sterilize milk and to destroy bacteria both *in vivo* and *in vitro*. Radiation *in vivo*, both as general radiation of the whole animal and local radiation to the site of injection, produced no changes in the course of streptococcus infections in guinea-pigs. In addition, no effects of the radiation could be detected on the precipitin titer of the pneumococcus antisera from rabbits.

The study of diphtheria toxin was made in two series of experiments. First series: One sample of toxin was chilled in ice water to 7° C., then exposed to radiation until the temperature had risen to 38°–40°C. (about four minutes). When such a temperature was attained the sample was taken out of the high frequency field and chilled again in the ice water. This process was repeated until the total time of radiation was fifteen to sixty minutes. A control sample was kept at the identical temperatures with the same rate of heating and cooling by alternate chilling in ice water and immersion in a small heated water bath. The temperature attained did not affect

the toxin of the control sample, but the radiated sample was definitely attenuated in as short a time as fifteen minutes.

The second series was performed with cooling during the process of radiation. The toxin was placed as a film about 0.5 mm in thickness between two walls of concentric tubes and a chilled fluid was circulated in the inner tube.[1] The type of fluid used for the cooling was found to be of very great importance, because absorption of the electric waves by the central core of cooling fluid conditioned a loss of energy available to affect the toxin. The balanced molecular structure of benzol is such that it has no resultant dipol, its dielectric constant is the same at all frequencies, and therefore no absorption bands should be anticipated. The temperature of the thin toxin layer was determined by the use of a thermocouple at all times during the course of the radiation, and additional experiments were performed to investigate any direct action of the radiation on the thermocouple. Corrections were made accordingly for this latter action. The controls in this series were placed in similar thin films and at the same temperatures. Radiation of the type described above with the benzol cooler was found to be active in producing deterioration of the toxin in thin films at temperatures as low as 15° C. Similar results were obtained with cold air as a cooler.

It is notable at this time that although D'Arsonval had pronounced that a film of toxin was necessary in such work, the toxin in our hands was not in the beginning radiated in a film with any object other than efficient cooling. Later when the means were devised to cool a full column of the toxin, the radiation on such a column was found to be ineffective at temperatures under 18° C. It is remarkable that although the physical conditions of D'Arsonval's work are very remote from those employed here, we still arrived independently at the same conclusion; namely, that a film of the toxin seems to be essential to the greatest action of the radiation.

The method of assay of the results obtained was both by skin tests in guinea-pigs and by tests of the lethality of the toxin as well. In general, so far in the work, the two methods of assay have been found to be in close parallel, with the skin test being a somewhat quicker and possibly more delicate measure. The inactivation of the toxin is not complete, but by fifteen minutes' radiation with the benzol cooler at temperatures never above body temperature, the toxicity is so diminished that twenty-five skin test doses injected intradermally into a guinea-pig give the same reaction as that obtained with one skin test dose of the control toxin. One hour's radiation makes twenty-five skin test doses equal to one half of one skin test dose, and six hours' makes fifty skin test doses (one minimum lethal dose) equal to one half of one skin test dose of the control.

The exact nature of the mechanism of the change is not clear at present, but that the action occurs without heat effect is apparent. The different responses to changes in wave-length and the action on the two other major toxins, botulinus and tetanus, together with development of methods to measure accurately the output between the plates at all times may in the future clarify the problem.

We are further interested in the suggestion of D'Arsonval that the irradiated diphtheria toxin should be investigated with regard to its properties as an immunizing substance.

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[1] The efficiency of such a cooling mechanism was tested by special experiments with the whole device immersed in a water bath at 55° C. The cooler was found to preserve the toxin unchanged for three hours. Such a temperature was never approached in the radiation experiments.

RESULTS OF TOTAL AND PARTIAL ADRENALECTOMY AND ADRENAL TRANSPLANTATION IN THE ALBINO RAT

It has generally been considered that a large proportion of white rats will survive total extirpation of the adrenal glands, and this has been attributed to the presence of accessory adrenal tissue. In the course of experiments on the survival of adrenalectomized rats at different atmospheric pressures it soon became evident that all the control animals, *i.e.*, adrenalectomized but kept at normal atmospheric pressure, died showing the classic symptoms of adrenalectomy, *viz.*, excessive prostration, muscular weakness, anorexia, etc. On the contrary, those rats in which a small fragment was left *in situ* survived indefinitely. This was so directly opposed to the results of other investigators that we have made it a point of special study.

To date, a total of forty-eight rats has been operated on. In thirty-two of these both adrenals were removed at the same time. All these animals died, the survival period varying from three to twenty days. None of these rats gained in weight after the operation; on the contrary, there was a steady decline. Rat ♂ 2035, typical of all these cases, was at the time of operation seven months old, weighed 358 grams, was in excellent condition; it died eight days after operation and weighed 304 grams; at autopsy

it was found that the fat was entirely depleted, there were no adhesions and the wound was cleanly healed.

In five rats a very small portion of one gland was left *in situ*. All these rats survived; there was never loss in weight throughout the period they were under observation. Rat ♀ GH4126 is typical—at time of operation it weighed 167 grams, and now, 125 days after operation, it weighs 193 grams and is in excellent condition.

This, however, does not rule out the possibility of the presence of accessory adrenal tissue, and that such tissue may have taken over the function of the normal gland. To test this point we transplanted a small fragment of adrenal tissue within the ovarian capsule, inserting it through a small slit. In five successful transplants the animals showed no loss in weight and appeared indistinguishable from normal animals for an indefinite time. Two of these rats are still living and are in perfect condition. Three were observed for approximately a month, at the end of which time the ovary containing the transplant was removed. Had accessory tissue been present, these three rats should have survived, since the second operation did not involve the site of the first, and removal of one ovary does not interfere with the normal condition of the animal. But following the removal of the ovary, in each case, there was the gradual loss in weight characteristic of adrenalectomized animals, and the usual train of symptoms appeared. One died within eight days. The other two died within fifteen days.

This work shows that the rat is no exception to the rule; it does not survive complete adrenalectomy, and that very small fragments left *in situ* or successfully transplanted within the ovarian capsule suffice to keep the animal alive and in good condition.

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THE METABOLISM OF THE BRUCELLA GROUP IN SYNTHETIC MEDIA

Many important questions concerning the biology of the Brucella group remain unsolved. As a part of an extensive program an effort has been made to analyze the elementary food requirements according to the principles evolved by Braun. After considerable experimentation a series of synthetic media in which 22 strains of the Brucella grow freely have been developed. Doubly distilled water, highly purified chemicals and Pyrex glassware have been used in the experiments. The growth, although moderate in the first generation, has improved after the fifth passage, indicating a gradual adaptation of the strains to the protein- or peptone-free environment. The following facts are worthy of note.

Cystine is one of the essential N-sources. Asparagine in combination with cystine enhances multiplication. Sodium or ammonium citrate serve as carbon and energy sources. Cultures of recently isolated strains are obtained provided sodium carbonate and potassium acid phosphate is mixed in concentrations which will give a pH of 7.0. In all probability the CO_2 thus evolved fulfils the requirements of the sensitive strains. Twenty parts per million of iron either as ferrous or ferric ion has a stimulating effect. Glycerol is not indispensable but in concentration of 2 per cent. enhances the growth of every Brucella type. Physical and not chemical factors are responsible for the growth-promoting properties of this alcohol. The surface tension and physical consistency of the substratum play an important rôle. In liquid synthetic media the growth is sparse but the addition of 0.2 per cent. agar repeatedly washed in distilled and redistilled water accelerated the multiplication many fold. In this connection it is of interest that progressively increasing amounts of agar diminish the growth until it is completely inhibited at 1.5 per cent. concentration. A semisolid synthetic medium with 0.1–0.3 per cent. agar permits the cultivation of recently isolated CO_2 tolerant strains to grow at the normal oxygen tension of air.

The details of the various experiments on the N and S requirements, C and energy sources, essential cations and anions, optimal surface tension, osmotic pressure, utilization of carbohydrates, intramolecular respiration together with growth curves will be published in the *Journal of Infectious Diseases*.

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BOOKS RECEIVED

Buchanan, Estelle D., and Robert E. Buchanan. *Bacteriology for Students in General and Household Science.* Third edition. Pp. xvi + 532. 243 figures. Macmillan. $3.00.

De Broglie, Louis. *An Introduction to the Study of Wave Mechanics.* Translated by H. T. Flint. Pp. vi + 249. 14 figures. Dutton. $4.25.

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Riggs, Norman C. *Applied Mechanics.* Pp. x + 328. 387 figures. Macmillan. $3.75.

Tarr, W. A. *Introductory Economic Geology.* Pp. ix + 664. 249 figures. McGraw-Hill. $5.00.

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THE ORIGIN OF LAND PLANTS[1]

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THE problem of how the existing vegetation of the earth has come into being is one of perennial interest to the botanist, and I have chosen as my subject some of the conclusions to which botanists have come as to the history of the plant life which now occupies so large a part of the earth's surface.

The evolution of the plant kingdom always has had for me a special fascination, and since my first serious botanical studies nearly fifty years ago, the subject has occupied a prominent place in my scientific work. Not, perhaps, a particularly practical subject, as ordinarily understood, and no doubt some of my audience may think it a waste of time to have devoted so large a part of one's life to such investigations. "What use is it all?" one may ask, and the answer must depend on one's outlook on life.

I might reply that it has furnished me a livelihood—that I have been well paid for doing what I most wanted to do. This might be given as a "practical" result of my activities. I am afraid, however, that I have even encouraged some of my students to go ahead in similar unpractical lines of research, hoping that they might have some of the same satisfaction in their life work that I have found. If I have succeeded in some degree in this, I feel that I have as truly performed a service as if I had merely equipped them to go out into the world and fight for money and what it brings.

The pursuit of science for the love of it, and not primarily for the material rewards it may bring, has results that no money can purchase. Such a love of

[1] Address of the president of the Pacific Division of the American Association for the Advancement of Science, Eugene, Oregon, June 20, 1930.

science may well be put by the side of the other arts, music, literature or painting—those things which we feel must have a place in the life of every truly civilized being. Having these resources, one need not be afraid of one's own company, and is independent of the multiform devices for killing time which at the present day seem indispensable to so large a part of mankind.

If we glance at the plants about us, we soon realize that a very large majority live on land, the number of aquatic species being relatively small. Of the land plants the major part are the familiar flowering plants. Next in number are the many fungi, including a host of parasitic forms, rusts, mildews, etc., with which the farmer and gardener are only too well acquainted. These, however, I hardly feel competent to discuss. Since there is abundant evidence that the primitive plants were aquatics, the botanist has to meet the problem as to the factors concerned in the migration of the aquatic ancestors of the existing land plants to their present terrestrial environment, and the extraordinary evolution of new forms which has accompanied this radical change of life on land.

If all the plants, from the earliest times to the present, had left fossil remains throughout the successive geological ages, the story of the evolution of the plant kingdom would be a comparatively simple matter; but, unfortunately, the fossil record is extremely imperfect, especially as regards the more primitive plants, which are, for the most part, too perishable to have left recognizable fossil remains. Where more resistant structures are present, such as the lime or flint incrustations of some algae, or the woody tissues of the so-called "vascular" plants, like ferns and many flowering plants, these have often been preserved very perfectly, either as impressions, or less commonly as actual petrifactions, like fossil wood, where one may make thin sections for microscopic study which sometimes show the cellular structure almost as perfectly as if made from living tissue.

From such fossil remains much has been learned about the early history of many important groups of plants, and we may hope for much more assistance from further discoveries by students of fossil plants in deciphering the story of plant evolution.

Owing to the incompleteness of the fossil record, we must have recourse to a very thorough comparative study of the living plants in our endeavors to trace their relationships. If we compare any two plants, we shall find a greater or lesser degree of correspondence in their structure, and from the degree of similarity between them we assume an indication, to a great extent, of the degree of genetic relationship. This comparative morphology must include not only the adult structure, but also the development of the organs of the plant from their earliest stages. Such study may embrace the whole life history of the plant from the germ-cell, or egg, to its mature form. Such a study of the development of the individual we call ontogeny, and such ontogenetic studies are of great importance in the establishment of a natural system of classification, as the developing embryo repeats, to some extent, the history of the group to which it belongs—or its phylogeny.

While comparative morphology is probably the most important factor in determining relationships, it is by no means infallible, and one has to exercise great caution in drawing one's conclusions. This is especially true where certain superficial organs are concerned. Thus the leaves of some seaweeds, mosses and flowering plants have a marked similarity in form and function, but we are certain that they are independent developments in three entirely unrelated plant types. Such organs have been called "analogous" but perhaps a better term is the more recent one, "homoplastic" as opposed to "homologous" organs, which latter are assumed to be genetically related. It is often difficult, however, to decide with certainty whether certain structures are really homologous or merely homoplastic.

Geologists tell us that in the earliest periods of the earth's history the seas were much less salt than at present, and that the first organisms probably lived in fresh water. Some of the simplest living things, like certain Protozoa and simple Algae, may have persisted to the present, little changed from these remote ancestors, since they are perfectly adapted to their fresh-water environment, which has not altered materially from the earliest times. It is, therefore, among such relicts of ancient life that we must look for the nearest relatives of the ancestors of the modern vegetation.

The term alga is usually given to all the plants below the mosses which possess the characteristic green pigment chlorophyll. Several independent classes of algae are recognized by the most recent students of the algae, most of these classes having, in addition to chlorophyll, other pigments. Two of these classes, the brown algae and the red algae, the former including the giant kelps of the Pacific Coast, are with few exceptions inhabitants of salt water. It is these highly specialized forms that mark the culmination of the algae, and at the present time they are the dominant plants of the ocean and have evidently best solved the problem of life in salt

water; to their peculiar environment are doubtless due their most marked characteristics. There is little reason to suppose that any of the land plants have arisen from these seaweeds.

The green algae, on the other hand, probably represent the remnants of the primordial fresh-water vegetation, which has persisted with little change to the present time. It is from forms related to these primitive green algae that there is a good reason to believe the first land plants are descended. One of these classes, the Chlorophyceae, have the chlorophyll unmixed with other pigments, and probably represent the nearest approach to the lower land plants, since the latter have much the same cell structure, including pure-green chromatophores, and with relatively few exceptions are dependent on fresh water for their existence. We may assume that the land plants, now the predominant type, are descended not from the large complex seaweeds but from much simpler fresh-water green algae. One order of the Chlorophyceae, the Ulothricales, show approximately, at least, what may have been the course of evolution in the ancestors of the earliest land plants.

Many algae are unicellular organisms, and sometimes are capable of locomotion closely resembling some of the simplest animals, Protozoa; but they differ from these animal cells in the presence of chlorophyll, which is associated with the power of utilizing the energy of sunlight for the manufacture of organic compounds, *e.g.,* starch and sugar from CO_2 and water. This power of photosynthesis is the essential character of all green plants.

Starting with this free-swimming green cell, the first step in the development of the plant-body is the loss of motility and the investment of the cell with a definite membrane, or cell wall. By repeated division in a single plane such a cell may give rise to a row of similar cells—a filament. Sometimes the contents of a cell may escape, as a naked free-swimming "zoospore"—or several zoospores may be formed from the cell contents. These later settle down, develop a cell wall and grow into a new filament.

This reversion of the reproductive cells to the motile condition is a feature which is retained even in some of the seed-plants, and is perhaps the strongest evidence of the aquatic origin of the land plants.

The simplest type of a multicellular plant is the simple filament, or cell-row. Should divisions occur in two planes, a cell-plate results, and if in three planes a solid plant body, which may assume various forms, and in such large algae as many red and brown seaweeds may reach a size and complexity rivaled only by some of the higher land plants. No fresh-water algae show anything comparable to these salt-water giants.

Unlike the sea with its constant water level, where no seaweeds are exposed to prolonged drying up, most bodies of fresh water are more or less subject to marked changes of level as well as to much greater range of temperature than prevails in the ocean, while shallow ponds and streams are often completely dried up for long periods. We find, therefore, that most fresh-water algae have developed means of surviving periods of stress due to cold or drought. Some can exist with a minimum water supply and survive long periods of complete desiccation. The little unicellular plant, Protococcus (to use the old name), which forms dark-green films on shady walls, old flower-pots, etc., may be cited as an example. A few green algae may even become true land plants, developing delicate roots which penetrate moist soil and absorb water to replace that lost by evaporation. The curious little *Botrydium* is an instance of such a terrestrial alga. However, the limitations of such a simple form are obvious, and so far as I know, none of the algae have developed a really successful land plant.

The problem of surviving cold and drought has been solved by many green algae in quite a different fashion. In addition to reproduction by simple cell division and growth, special reproductive cells, known as gametes, are developed. The gametes are sexual cells—that is, the fusion of two of them is necessary for their further development. This fusion cell, the zygote, in most cases, develops a heavy cell-wall and forms a "resting-spore" capable of resisting cold and drought, which would be speedily fatal to the parent plant. When conditions are favorable the zygote germinates, the contents usually divide into several cells which escape as free-swimming zoospores, each of which develops into a new plant.

The gametes may be alike, but in most cases there is a differentiation into large female gametes or eggs, and much smaller males, or sperms, the latter being always actively motile, while the female gamete is usually non-motile, and is retained in the mother-cell (oogonium), where it is fertilized by the active sperm.

Although it is generally assumed that the first land plants were derived from some fresh-water green algae, it must be admitted that at present we know of no forms which satisfactorily bridge the gap between the algae and the simplest land plants—the so-called archegoniates.

Of the algae, the genus *Coleochaete* shows the nearest approach to the archegoniates in the development of the zygote, which enlarges greatly after

fertilization, and on germination produces a much greater number of spores than any other green alga. This is obviously a great advantage. However, the differences in the development of the reproductive organs and the zygote, which develops zoospores on germination, are too great to indicate any direct relationship between Coleochaete and any known archegoniate.

The first invasion of the land by the algal ancestors of the higher plants must be regarded as perhaps the most momentous event in the history of the plant kingdom.

In the comparatively uniform environment of aquatic life there is much less scope for variation and selection to operate; but once established on land, surrounded by air instead of water, the fundamental growth factors—moisture, temperature, light and gravitation—become far less stable and the range of variation is evidently greatly increased, with a correspondingly enlarged field for the operation of natural selection. The results we see in the enormously greater range of structure in terrestrial as compared with aquatic organisms, both plant and animal.

When the plant exchanges its aquatic habitat for life on land it must undergo radical changes in structure. First in importance is the solution of the water problem. The submersed aquatic, surrounded by water, has no need for special organs for absorbing water, which is taken in at all parts of the surface, nor is there need for protection against loss of water by evaporation. The land plant, on the other hand, must be able to extract water from the soil, both for obtaining food and for making good the loss of water by evaporation into the air.

We find, therefore, that the typical land plants develop special organs, roots, for water absorption, and the surface cells of the stem and leaves have their outer walls more or less perfectly water-proof, and thus check evaporation. It is true that some of the lower land plants, such as many mosses and lichens, and even some ferns, can absorb water directly by their surface cells—very much as an alga does—but such plants dry up completely and remain dormant in dry air.

A submersed plant—whether alga or such a flowering plant as a pond-weed—is buoyed up by the dense medium in which it is suspended. Taken from the water, it collapses completely. The land plant must develop special supporting or "mechanical" tissues to overcome the force of gravity, or else lie prone on the ground, as we see some liverworts, among the most primitive of the land plants, and in this respect they recall their kinship with the algae.

With the increasing size of the land plants, in addition to the purely supporting or skeletal tissues, there has been developed a very complete system of conducting tissues through which water and the substances dissolved in it are transported through the plant. The woody bundles extending through the root and stem and the elaborate network of veins in the leaves serve both for giving firmness to the organs and as routes for water transport.

Since atmospheric conditions vary greatly as to temperature and moisture, land plants have had to adjust themselves to such extreme conditions as those of the saturated equatorial forest, the burning desert and frozen Arctic tundra. The water needs of a banana growing in the jungles of Borneo are very different from those of a cactus in the Colorado Desert or a dwarf willow in northern Alaska, and the temperature requirements are equally diverse. The banana, with its high water demand, is very limited as to its tolerance of temperature changes, while the willow, able to exist with a very small amount of water, can endure a range of 150° F. or perhaps more—a condition quite inconceivable for any truly aquatic plant.

All the typical land plants, *i.e.*, mosses, ferns and flowering plants, have much in common, and their reproduction is essentially the same. The egg-cell, when fertilized, instead of developing a resting-spore, as it does in the green algae, at once begins to grow and divide, so that a multicellular embryo results. Hence the name embryophyte has been proposed to include all these higher plants.

Some of the lower moss-like plants, the liverworts, probably resemble pretty closely the first land plants. These are small plants of very simple structure, lying flat on the ground, to which they are fastened by delicate roots. Structurally some of these liverworts are less complex than many algae, being composed of almost perfectly uniform cells. The green algae which seem to show the greatest resemblance to the liverworts are the Ulothricales, already referred to. Among the liverworts, one order, the Anthocerotales, closely resembles the Ulothricales in usually having but a single chromatophore in the cell—a condition found in many green algae.

A few liverworts are true water plants, and the life history of one of these suggests what may have been the transition from the aquatic environment to life on land. This liverwort, *Ricciocarpus*, usually is a floating aquatic. If, however, the water dries up, the plant settles on the mud and grows more vigorously than it does in the floating condition. Roots are developed, and the form of the plant becomes quite altered. It suggests that in similar

fashion the algal ancestors of the land plants, stranded by the evaporation of the water, may have developed roots as the result of the contact stimulus of the solid earth, and thus would be able to prolong their growing period. It is conceivable that in some such manner was inaugurated the line of land plants which was destined to become the dominant type of the future.

The essentially amphibious nature of all the more primitive land plants is shown by their dependence on free water for fertilization. In all these the reproductive organs are very characteristic structures. If we examine these in a liverwort, we find the egg-cell contained in a flask-shaped structure, the archegonium. Since this archegonium is very much the same in the mosses, ferns and even in some of the lower seed plants—these have been called archegoniates. The male gametes are also borne in multicellular organs, antheridia, but these are much less uniform than the archegonia. However, in all these forms, the male gametes or sperms are free-swimming, ciliated cells, like those of the green algae, and in order that they may function, free water is necessary. Only when they are covered with water can the reproductive organs open and permit the sperm to escape and penetrate the open neck of the archegonium, and thus reach the egg-cell.

The embryo resulting from the fertilized egg develops into a structure very different from the plant which bears the gametes, and which is therefore called the gametophyte or sexual plant. The one produced from the embryo does not become free, but remains attached to the gametophyte upon which it lives as a parasite. Sooner or later a large part of the inner tissue of the embryo develops into special reproductive "sporogenous" cells, each one of which gives rise by division to a group of four spores. The fully grown embryo, therefore, is the non-sexual or neutral plant, or sporophyte.

In the process of fertilization there is a fusion of the nuclei of the sperm and egg, and the fusion cell, or zygote, has twice as many chromosomes as the gametes. The chromosomes are those remarkable constituents of the nuclei, the supposed bearers of hereditary characters. The nuclei of the gametes are said to be haploid, while the zygote nucleus, with the double number of chromosomes, is diploid. In all embryophytes, the diploid character of the cells of the sporophyte persists until the first division of the spore mother-cell, when by a peculiar type of nuclear division—the reduction division, or meiosis—the haploid number is restored, and the gametes developed from the germinating spores have haploid nuclei.

This alternation of the sexual with the non-sexual or neutral phase, produced as the result of fertilization, characterizes all embryophytes.

Of these, the forms which most nearly resemble the algae are some of the liverworts and the gametophytes of some of the ferns, and there is no great difficulty in comparing these with algae; but when we consider the reproduction, the resemblances are not so obvious. The complex, multicellular archegonia and antheridia are very different from the usually unicellular organs of the green algae. It is true that in some of the algae—especially the brown algae, the cells containing the gametes are massed in groups of definite form, known as gametangia, and it has been suggested that possibly from similar gametangia in some green algae the archegonium and antheridium of the embryophytes have been derived. This, however, is only a guess.

The more critically the archegoniates are studied, the more evident it becomes that the living forms are remnants of a number of independent lines of development whose relationships with each other are to say the least uncertain. Two main groups are generally recognized: the bryophytes—mosses in a broad sense; and pteridophytes, of which the ferns are the typical representatives. This division is based upon the relative importance of gametophyte and sporophyte—the former predominant in the bryophytes, the latter in the pteridophytes. This classification, however, can hardly be accepted as an entirely scientific one.

While the gametophyte of many liverworts much resembles in appearance some of the algae, there are many others, and especially true mosses, in which the gametophyte may develop into a plant of relatively large size, in extreme cases forming leafy shoots a foot or more in length with specialized tissues for support and water conduction, suggesting the structures of the sporophyte in the so-called vascular plants. The root system, however, is deficient, and mosses depend largely upon the direct absorption of water through the leaves, behaving much as an alga would do.

The apparent inability of the gametophyte to develop adequate roots perhaps accounts for its failure to reach dimensions at all comparable to those of the higher plants, and in none of the larger ones are the skeletal tissues sufficient to enable them to maintain a truly upright position.

The gametophyte of the archegoniates is the descendant of some strictly aquatic plant, and it is not unlikely that there are limits beyond which such a type can not progress. The higher mosses, which represent the most perfect development of these

originally aquatic organisms, can not be said to have quite satisfactorily solved the problem of a plant perfectly adapted to life on land.

The further evolution of the land plants is mainly bound up with the neutral generations, the sporophyte. The origin of this we believe is to be found in the zygote or resting-spore of some green algae. This zygote may be said to represent a terrestrial phase of the alga—a condition fitted to survive drought and thus carry the plant over from one growing period to another. The fact that the zygote, the equivalent of the sporophyte of a liverwort or fern, is from the very first a structure fitted for life outside the water must be borne in mind in following the further history of the higher plants.

In those algae which are assumed to be the nearest relatives of the archegoniates, the zygote on germination produces several (usually motile) spores, each of which gives rise to a new plant—an evident advantage over such forms as produce but a single plant from the zygote. In Coleochaete—already referred to—the increase in size of the zygote, subsequent to fertilization, and its development into a globular multicellular body, which to a certain extent resembles the young embryo of some of the archegoniates, have suggested a possible relationship between them. While it is highly improbable that there is any direct relationship, it is pretty certain that the sporophyte of the first archegoniates must have been derived from a structure not very different from that found in Coleochaete.

A study of the development of the sporophyte of the bryophytes shows the general trend of evolution leading to the higher so-called vascular plants. The evidence, however, is much too fragmentary to permit of more than general conjectures as to what were the ancestors of the pteridophytes.

The simplest known sporophyte is that of a liverwort, *Riccia*. The embryo becomes a globular body, all of whose cells, except an imperfect superficial layer, produce spores. In most liverworts, however, the embryo is divided into an upper sporogenous region, and a basal sterile region which later forms the foot, and a more or less conspicuous stalk connecting the foot and the sporogenous region, which becomes a capsule containing the spores. The foot penetrates the surrounding tissue of the gametophyte, from which it draws the water and food materials for the further growth of the sporophyte, which thus lives as a parasite upon the parent gametophyte.

In none of the true liverworts does the sporophyte attain any considerable degree of independence, but serves merely as an organ for spore production.

In the true mosses the sporophyte becomes much more important, and spore production is to a considerable extent subordinated to the vegetative life of the sporophyte. The growth of the sporophyte may continue for a long time before any sporogenous tissue is apparent, and the amount of this is small compared to the sterile tissue. Some of the latter develops chlorophyll, which enables the plant to utilize the CO_2 of the atmosphere and is therefore quite independent of the gametophyte for its organic food, although it still obtains water and mineral substances through the foot, and never becomes entirely independent. A well-developed conducting tissue may also be formed, and a very elaborate mechanism for the dispersal of the spores. These highly differentiated structures indicate that the true mosses form a very specialized class with little direct connection with any other plants.

The very early history of the fern embryo is quite like that of the simpler liverworts, but very soon a radical difference may be noted. Instead of the globular or cylindrical form of the liverwort sporophyte, terminating in a single spore-capsule, the fern embryo at a very early stage shows the development of special organs. A large foot is present, but instead of the spore capsule two prominent outgrowths appear, one of which grows upward and soon appears as a fan-shaped green leaf, while the other, bending down, is a true root, which fastens the young sporophyte to the ground and thus connects it directly with the water-supply. With the leaf, a special organ for photosynthesis, and the roots, furnishing water, the sporophyte for the first time becomes an independent plant. A definite stem apex is established and new leaves and roots continue to form, and it may reach a large size and live for many years.

During the early stages of development, the sporophyte receives nourishment from the gametophyte through the foot, exactly as in the liverworts; but with the establishment of the roots, the gametophyte dies, leaving the sporophyte established as an independent plant.

The production of spores is often delayed for many years, the sporophyte increasing in size and developing a complicated system of organs and tissues. Of the latter the most notable is the elaborate system of conducting tissues—the "fibro-vascular" bundles, a feature of all the higher or vascular plants. In the common ferns the spores are contained in special capsules—sporangia—which are borne upon the lower surface of the leaves. The form and position of the sporangia are important factors in the classification of the pteridophytes.

Of special importance in connection with the

origin of the pteridophytes is the very peculiar order Anthocerotales, or horned liverworts, already referred to, and usually considered to be true liverworts. They differ so much from these, however, that their separation, as a distinct class, seems warranted. Of all the bryophytes, the gametophyte of the Anthocerotales, with its very simple structure and alga-like chromatophores, most nearly resembles the green algae from which it is assumed the archegoniates are descended. On the other hand, the gametophyte and reproductive organs show some striking similarities to the lower pteridophytes. We might perhaps say that in a sense the Anthocerotes represent a synthetic type, allied on the one hand to the green algae, on the other to several distinct lines of bryophytes and pteridophytes.

While the gametophyte is so simple in structure, in which it agrees with some of the more primitive ferns, the sporophyte may show a long-continued growth, and in exceptional cases may attain practical independence. In the genus *Anthoceros* the sporophyte is a slender cylindrical body which may reach a length of ten centimeters or occasionally even more. At the base is a large bulbous foot, and above the foot is a zone of actively growing tissue to which the elongation of the growing sporophyte is due. In the most highly developed cases the foot becomes much enlarged, and possibly may come into direct contact with the earth. As in the true mosses, there is a great reduction in the amount of sporogenous tissue, outside of which is a thick mass of green cells, active in photosynthesis, and as in the higher plants, stomata, or breathing pores, occur in the epidermis. Occupying the axis is a strand of elongated cells which in exceptional cases may be fairly described as a primitive vascular bundle—in short the sporophyte in *Anthoceros* may very fairly be compared with that of the most primitive pteridophytes.

In speculating upon a possible connection of the Anthocerotes with the origin of the pteridophytes, it is noteworthy that among the oldest fossil remains of land plants certain extremely simple vascular plants, the Rhyniaceae, from the lower Devonian formations of Scotland, were in structure extraordinarily like some large sporophytes of *Anthoceros*.

In the evolution of the sporophyte of the archegoniates, the most significant fact is the progressive reduction of the spore product and the increasing importance of the sporophyte as a whole, compared with the gametophyte. In the true liverworts the life of the sporophyte is brief, and its exclusive function is the production of spores. In the mosses and Anthocerotaceae, the growing period of the sporophyte is greatly prolonged on account of the production of green tissue which enables it to make its own food, but it is still dependent on the gametophyte for water, as it does not develop a root. The sporogenous tissue is greatly reduced in amount. Finally, in the ferns, by the development of a root which gets its water-supply directly from the earth, the sporophyte becomes a truly independent plant, in which the spore-function is more or less incidental.

The increasing importance of the sporophyte in the life cycle of the plant is thus bound up with transformation of potentially sporogenous tissue into sterile or vegetative tissue. The significance of this progressive sterilization of sporogenous tissue as a factor in the history of the land plants has been treated at length by the distinguished British botanist, Professor F. O. Bower.

Fossil Record

When the first land plants appeared we do not know. The earliest known fossil records are in the Devonian rocks, but these are of vascular plants related to some living forms, and it is evident that they must have had a long ancestry of simpler forms behind them.

Mosses and liverworts are too perishable to have left fossil traces, except under very unusual conditions, and fossils of these, even in more recent formations, are very scanty and fragmentary, and throw little light upon their early history.

Of the vascular plants, however, including ferns, club-mosses and other existing types, there are abundant fossils, extending from the lower Devonian formations to the present. These fossils include not only impressions of stems, leaves and fructifications, but in many instances petrifactions which make it possible to study their microscopic structure, and these have furnished much valuable information as to the nature of some of the oldest known vascular plants. All the existing classes of pteridophytes can be traced back to the early Devonian formations and indicate that they have probably originated from independent but similar bryophytic ancestors.

As is so frequently the case, the most specialized of these ancient types have disappeared before their still more perfect descendants, while the lower and more generalized have persisted, or have left descendants which have been able to occupy positions to which more specialized forms are not so well adapted. Thus the giant pteridophytes of the Coal Measures have given way to the more modern trees, and to-day the tree-ferns alone remain to remind us of their past glories. The more humble ferns and club-mosses still play an important rôle in the vegetation where conditions are favorable, as in New Zealand and the mountain forests of the tropics; and a few, like the field horsetail (*Equisetum*) and the common bracken fern, manage to hold their own against the

predominant flowering plants, even in very unfavorable conditions.

Of the existing pteridophytes the ferns form a very large majority, but most of the types found in the older formations are now extinct and have been replaced by those now existing, which are of relatively recent origin and which have succeeded, like the still more recent flowering plants, in adapting themselves to existing conditions. Some of the modern tree-ferns rival in size their fossil prototypes. The other living pteridophytes, the horse-tails, club-mosses and Psilotales, are few in number, compared with the ferns, and are but poor relations of the giant Lepidodendrons and Calamites of the Coal Measures.

As the primitive land plants adapted themselves more and more perfectly to the increasingly diverse conditions associated with their new environment, the evidences of their aquatic ancestry became less apparent, and finally in the highest of all plant types, the seed plants, disappeared.

The mosses and ferns illustrate the transitional stages through which the seed plants have passed in their evolution from their primitive aquatic ancestors, the green algae. In the bryophytes the history of the gametophyte shows the limitations of this aquatic organism in adjusting itself to the radically different water conditions to which land plants are subjected. Even the most perfect gametophytes, such as those of the higher mosses, owing to their failure to develop adequate roots and efficient skeletal tissues, are unable to attain any but the most modest dimensions. Moreover, these plants are essentially amphibious and free water is necessary for fertilization.

In the ferns the development of the race centers in the sporophyte—the neutral generation. This, being the product of the fertilized egg-cell, is equivalent to the zygote or resting-spore of the ancestral green algae from which it is assumed that the mosses and ferns are descended. As the zygote of the algae is usually fitted to survive periods of drought, we may say that the sporophyte from its earliest beginning has been an organism fitted for life on land. It evidently has a potentiality for development on land that is not shared by the essentially aquatic gametophyte. It might be said that nature, having in the mosses exhausted her resources in the endeavor to transform the aquatic gametophyte into a successful land plant, turned to the spore-bearing generation as a more promising subject for experimentation. In the ferns, therefore, we meet for the first time a sporophyte which has true roots with sufficient capacity for water absorption to provide for the further development of the sporophyte, which thus becomes a perfectly developed land plant, with stem, leaves, roots and elaborately developed tissues.

With the increasing importance of the sporophyte there is a gradual reduction in the gametophyte, which becomes more and more insignificant, finally resulting in its reduction to minute, almost microscopic size in what are known as the "heterosporous" pteridophytes. These heterosporous forms occur in several unrelated groups, and it is evident that heterospory has been developed quite independently in these.

Heterospory is the first step toward the development of the seed habit. In the ordinary ferns the spores are all alike, and the gametophytes developed from them bear both male and female gametes. Occasionally from similar spores gametophytes of two sorts—male and female—are produced, and in such cases the male plants are smaller than the females. In the heterosporous forms, such as the water fern, *Marsilia*, sporangia of very different sizes are developed: large ones, in which only one very large spore—the megaspore—comes to maturity; and small sporangia, in which all the spores—microspores—develop. The gametophytes in both cases are reduced to a few cells and are retained within the spores, and the whole development of the gametophytes is completed within less than twenty-four hours. From the megaspore, the female gametophyte is formed; from the microspores, the male.

In the club-mosses of the genus *Selaginella*, the macrospores remain within the sporangium until the development of the gametophyte is far advanced and may even be retained permanently within it, and the growing gametophyte draws upon the tissues of the sporophyte for its nourishment, thus reversing the relation of sporophyte to gametophyte as compared with the lower archegoniates.

The seed is a further elaboration of the megasporangium. In the seed plants the megaspore is retained permanently within the sporangium, where it completes the development of the gametophyte and fertilization is effected. The embryo plant, enveloped in the double covering of the spore membrane and the sporangium wall, which becomes the shell of the seed, is very effectively protected from external vicissitudes, and during its development can draw upon the parent plant for its food supply. It moreover stores up in the ripe seed the reserve food which is necessary during germination. The advance of the resting stage of the plant, from the simple spore in the fern to the embryo within the seed, gives the seed plants a great advantage in the certainty and rapidity with which the new generation is established. The seed habit has resulted in a plant type peculiarly adapted to life on land, as is shown by the extraordinary development of seed plants at the present time.

All the primitive seed plants have their seeds ex-

posed on open leaves or scales, and are known as gymnosperms to distinguish them from the higher flowering plants, the angiosperms. Like the terms bryophyte and pteridophyte, these are convenient, but do not imply a necessary close relationship among all the members of the class.

The earliest seed plants, whose remains are found as far back as the Devonian era, were very different from any of the existing ones. Some of them were evidently related to the ferns and have been called pteridosperms or seed ferns. Others were related to the club-mosses, and still others are not clearly related to any existing types. The evidence that seeds were developed in a number of unrelated plants makes it extremely probable that the living seed plants also represent several independent lines of development.

Of the older types of seed plants still existing, the conifers—pines, firs, redwood, etc.—are the most numerous and familiar. The flowers of these are composed of closely set scales upon which are borne respectively the macrosporangia and microsporangia. The structure of these may be readily compared to that of some of the heterosporous pteridophytes. In the megasporangium a single large megaspore is formed within which a gametophyte with several archegonia is developed, much as in Selaginella. The megaspore, however, is retained permanently within the sporangium, and this necessitates a quite different method of fertilization. The megasporangium in the seed plants is known as the ovule.

The microsporangia are much like those of the ferns, and the microspores are formed in tetrads, as in all typical archegoniates, and are called pollen-spores. A very rudimentary gametophyte with two sperms is formed within the spore. The ripe pollen spores fall upon the apex of the ovule (megasporangium) and send out a slender tube which penetrates the tissue overlying the archegonia and discharges the sperms into the archegonia. Unlike those of the ferns, the sperms have no cilia. The pollen tube does away with the necessity of water for effective fertilization, and the last trace of the aquatic origin of these plants disappears.

In a number of the most primitive seed-plants, especially the fern-like cycads, motile sperms have been discovered. In these the pollen tube becomes greatly distended by an accumulation of water, and finally bursts and discharges the water together with the large ciliated sperms into a chamber which lies above the archegonia. So we see that, even in the seed plants, the same aquatic type of fertilization may occur that obtains throughout the whole archegoniate series from which these plants are descended.

That the seed habit developed a number of times in quite unrelated groups of pteridophytes is amply shown by the fossil remains of seed-bearing plants in the Paleozoic, as far back as the Devonian. Some one, or perhaps more than one, of the seed ferns were probably the progenitors of the living cycads and the abundant cycad-like forms of the Mesozoic formations. The cycads at present are few in number or species, but widely dispersed, and seldom sufficiently abundant to make them important constituents of the vegetation.

The conifers are preeminently the predominant gymnosperms of the present. Although the number of species hardly exceeds four hundred, they nevertheless, owing to their gregarious habit, are among the most important forest trees in many parts of the world—especially here on the Pacific Coast. Incidentally, they include the largest known trees.

It is pretty clear that the existing seed plants do not form a homogeneous assemblage. The gymnosperms show evident relationships with the pteridophytes, but the different orders, *e.g.*, conifers, cycads, may very well have been derived from quite independent pteridophytic stocks. The predominant modern flowering plants or angiosperms differ so markedly from the gymnosperms that it is a question whether there is any real relationship between them, and their origin is very uncertain.

The production of the seed marks the final step in the complete adjustment of the plant organism to strictly terrestrial conditions, and while seeds arose independently in several widely separated classes, most of the primitive seed plants have disappeared completely, or have left only a few descendants which maintain a more or less precarious existence at the present time.

One type of seed plants, however, has proved itself eminently adapted to modern conditions and comprises an overwhelming majority of living plants. These are the familiar flowering plants, or angiosperms, to use the botanical term. In the angiosperms the plant organism reaches its most perfect expression, and they now dominate the land floras of the whole world.

Plastic to a degree unequaled by any other plants, they have adapted themselves to the most diverse conditions. From the burning deserts of the tropics to the utmost limits of vegetation in the polar regions and on mountain summits angiosperms have made themselves at home. A few have even invaded the sea, and many live in swamps or completely submersed in lakes or rivers. Others, like the mistletoe or dodder, have adopted a parasitic life, and still others live at the expense of dead organic matter—or as we say are saprophytes, like the snow-plant of our high mountains. The parasitic and saprophytic

angiosperms recall the fungi, and as they have more or less completely lost their chlorophyll, must depend on other organisms for their organic food. While the ferns and gymnosperms have left abundant and well-preserved fossil remains whose nature is unmistakable, of the angiosperms, except in the later geological formations, only scanty traces have been found, and these are often of very doubtful nature.

It is not until the later Mesozoic formations are reached that certain evidences of angiosperms are encountered. From the Cretaceous upward, they rapidly increase in number and variety, and many existing types can be plainly recognized among the Cretaceous fossils.

The apparent sudden appearance of angiosperms in the lower Cretaceous rocks and the close resemblance of these early fossils to living types make it certain that there must have been a long line of more primitive forms preceding them; but of these "protangiosperms" we have no definite evidence, and at present there is much controversy as to what was the origin of the angiosperms.

The flowers of the angiosperms are much more highly developed than those of the gymnosperms, and it is difficult to compare them. The young seeds, or ovules, instead of being exposed on an open scale, as in the pine, are contained in a closed receptacle (ovary) usually composed of special leaves, or carpels, grown together. The development of the seed, however, is much the same as in the gymnosperms—except that the gametophyte is very much more reduced. The microsporangia, or pollen sacs, are borne on specially modified leaves, the stamens—and the stamens and carpels are the essential organs of the angiosperm flower.

The flower may consist of only stamens or carpels, and the two sorts of flowers may be on the same plant, as in the oak or corn, or they may be on different individuals, as in the poplars, willows and the date palm. As some of the oldest fossil angiosperms, like the poplars and sycamore, have such "diclinous" flowers, it is probable that this condition is more primitive than the much more common "perfect" flowers having both stamens and carpels. Many botanists, however, believe that the diclinous condition is the result of reduction from flowers having both stamens and carpels, but there are serious objections to this view.

Most of our common flowers are "perfect" or "hermaphrodite"—or to use a more accurate term, amphisporangiate. Moreover they usually possess a conspicuous floral envelop, which may be composed of nearly uniformly colored leaves, as in a lily, or there may be a double envelop—the green calyx and the highly colored corolla. As we have already noted, the ovules are borne in a closed ovary, which may be the base of a single carpel or may be formed by the junction of several carpels into a compound pistil.

The position of the ovules in the closed ovary requires special adaptations for insuring fertilization. In the gymnosperms the pollen spores fall directly upon the apex of the exposed ovule. In the angiosperms there is a special organ—the stigma at the tip of the pistil—which receives the pollen and facilitates its germination. The pollen tube grows downward through the tissues of the pistil until it reaches the ovule in the ovary, and fertilizes the egg-cell in much the same way as in the gymnosperms, and the subsequent development of the seed is very similar.

The effect of fertilization extends to the carpels, which are stimulated in growth and at maturity enclose the ripe seed in a fruit. This not only serves to protect the ripening seed, but is concerned also with its distribution. The development of the fruit has undoubtedly been an important factor in the success of the angiosperms in the struggle for existence.

The simple diclinous flowers of a poplar or oak might in a way be compared with the flowers of a pine, and as in the pine, there is a very large amount of light pollen formed, which must depend on the wind to carry it to the pistil. In the somewhat more specialized floral types, the stamens and carpels are close together, and there is a definite floral envelop. The number of parts is often indefinite, but with the increasing specialization the flower shows a constant number in its members, and the corolla becomes bright colored. Further specialization results in tubular flowers, sometimes of peculiar form. A study of these changes in form and color and the development in many flowers of characteristic scents shows very clearly that these are associated with the pollination of the flowers, mainly through insect agency.

Just when the association with insects as agents in pollination—entomophily as it is called—became established and thus started the extraordinary evolution of both insects and angiosperms is impossible to determine.

That the earliest angiosperms were entomophilous is exceedingly doubtful. The earliest known are allied to forms which at the present time have inconspicuous wind-pollinated flowers. Moreover, what is known of the insects of this period indicates that none of the specialized insects, like bees and butterflies, had yet come into existence; but later on, the rapid increase in the number and variety of the angiosperms indi-

cates that entomophily had begun to exercise a marked influence on their evolution.

The development of a showy corolla, which has been thought might have arisen from a transformation of stamens such as we may still see in some double flowers, is associated with the entomophilous habit, and it is by no means unlikely that the development of a true corolla was preceded by a condition in which the stamens, otherwise unchanged, became colored, and thus attractive to insects visiting the flower for pollen or honey. Such a condition may still be found, for example, in *Eucalyptus* and *Acacia*, where a corolla is either quite wanting or is relatively inconspicuous.

There is no question that the extraordinary numbers and diversity of the angiosperms are in very large measure the result of their adaptation to cross-pollination through insect agency. The seeds of cross-fertilized flowers have been shown to be more numerous and the seedlings more vigorous than those from self-pollinated flowers. It is also a legitimate assumption that increased variability due to crossing is advantageous in tending to develop new characters which are subject to natural selection. While insects are the principal agents in cross fertilization, certain birds may also act in this capacity. In America the humming-birds are familiar examples. They seem to show a special preference for red flowers, like the scarlet sage, fuchsias and some of the pentstemons, *Zauschneria*, etc. In other parts of the world, *e.g.*, South Africa, the sun-birds play a similar rôle, and these, too, seem to have a penchant for bright red. The aloes and red-hot poker in our gardens are examples of old world ornithophilous flowers.

While we may hesitate to accept all the conclusions of the enthusiastic students who first realized the immense importance of entomophily, we have no reason to doubt that the course of evolution of the two largest groups of plants and animals, angiosperms and insects, has been powerfully influenced by the mutual adaptations that have arisen in the association of these two groups of organisms.

The great variety of fruits developed in the angiosperms and the correspondingly varied devices for the distribution of the seeds have also been important factors in their success.

The early history of the angiosperms is very obscure, and we have no satisfactory evidence of their existence prior to the Cretaceous. The general uniformity of their essential structures makes it pretty certain that they have all originated from some common stock—or at least from some assemblage of related forms from which a number of lines of true angiosperms diverged. The prevalent division into two coordinate subclasses, monocotyledons and dicotyledons, is probably a somewhat artificial one. It is more likely that from an undifferentiated wide-spread primitive stock, for which the name protangiosperms has been proposed, a number of lines of true angiosperms arose, some monocotyledons, others dicotyledons.

Once established, the angiospermous type showed itself to be remarkably adaptable, and it soon established itself as the dominant element in the land vegetation. Whence arose their extraordinary plasticity can only be conjectured. The type of fruit, with the complete protection of the seed until its maturity, may have been one of the important factors in establishing their superiority over the gymnosperms; but this will not explain the extremely plastic plant body which contrasts so strongly with the limitations of the gymnosperms.

It may be that cross-fertilization among angiosperms arose early in their history and that thus a greater degree of variability was induced, resulting in the appearance of many modifications which could be seized upon by natural selection and thus tend to develop new types. Whatever may have been the reasons, it is their extraordinary adaptability that is at the bottom of the remarkable success of the angiosperms. One important phase of this is the utilization of animals for the distribution of pollen and seeds. Nearly all plants whose organs have been modified with reference to animal structures are angiosperms, and the great variety of flowers and fruits is doubtless connected with such adaptations. However uncertain we may be as to their origin, the remarkable fitness of these plants to modern conditions is obvious, and they have largely monopolized the land areas of the whole world. Only under exceptionally favored conditions are the lower plant types able to hold their own in competition with the all-conquering angiosperms.

OBITUARY

RECENT DEATHS

DR. IRA NELSON HOLLIS, professor of engineering at Harvard University from 1913 to 1925 and president of the Worcester Polytechnic Institute from 1893 to 1913, died on August 15, at the age of seventy-four years.

DR. LOUIS MURBACH, for many years head of the department of biology in the Central High School,

Detroit, died on July 24, aged sixty-six years. Dr. Murbach had been instructor in zoology at the University of Michigan and at Woods Hole and is known for his work on invertebrate zoology.

WALTER DEANE, botanist and ornithologist, known for his work on the flora of northeastern North America, died on August 3. He was in his eighty-third year.

DR. ASA BARNES DAVIS, chief surgeon at Lying-in-Hospital, New York City, known for his work in obstetrics, gynecology and abdominal surgery, died on August 13. He was sixty-eight years old. Dr. Davis was one of the founders of the American College of Surgeons.

W. J. GREENSTREET, formerly headmaster of Marling School and for thirty-one years editor of the *Mathematical Gazette* of the British Mathematical Association, died on June 28 at the age of sixty-nine years.

DR. CORNELIO DOELTER, of Vienna, an expert in precious stones, died on August 12 at the age of eighty years. He was a professor of the University of Vienna, where he lectured on mineralogy and the chemistry of minerals.

MEMORIALS

FRIENDS and associates of the late William Stanley, inventor of the electrical transformer, gathered at Fairview Hospital, Great Barrington, on August 6 to dedicate to his memory an elaborately equipped X-ray room. Forty-four persons and corporations, including the General Electric and Westinghouse Companies, gave $35,000 to equip the room and endow it. Mr. Cummings C. Chesney, of Pittsfield, a vice-president of the General Electric Company, made the presentation address. Mr. Chesney and Frederick Darlington went to Great Barrington in 1888 as the two original assistants to Mr. Stanley in his early laboratory work there. T. Ellis Ramsdell, president of the Fairview Hospital Corporation, accepted the gift, which had been suggested by the late Ralph W. Pope. Mrs. William Stanley and four of six sons were present at the ceremony.

THE *British Medical Journal* writes: "The Osler Club celebrated, on July 12 at its headquarters in London, the eighty-first anniversary of the birthday of Sir William Osler. Professor Harvey Cushing, having been welcomed as a friend of the club and as orator, gave an informal address, full of the charm and the whimsicality of his subject. He told of the early Weston days, of Father Johnson and of James Bovell, and of how under their influence Osler turned from the church to medicine. Professor Cushing, in his address, revealed some of the secrets of the writing of 'The Life,' and much else besides, to the delight of his audience. Dr. Arnold Klebs took up the tale, to be followed by Sir Arthur Keith. Between the three, with occasional help from Sir D'Arcy Power, Dr. Henry S. Wellcome and Mr. Philip Franklin, a lively discussion continued, until Mr. W. R. Bett, foreign secretary of the club, remembered that it was long past Osler's bedtime, and with a graceful tribute to the orator and to the influence of 'The Life' upon the growing generations of medical men, brought the meeting to a happy conclusion. Before the oration the club entertained Professor Harvey Cushing to dinner at the Langham Hotel."

THE *Journal* of the American Medical Association reports that Professor Paul Krause, Münster, president of the Rheinisch-Westfälische-Röntgen Society, has announced a plan to erect a monument to Röntgen in the birthplace of Lennep. The plan is to raise one fourth of the cost of the monument or $2,500 from American röntgenologists. So far $900 has been raised and it is hoped that the remaining $1,600 will be contributed by 1,200 röntgenologists who have not yet responded. Contributions are to be sent to Dr. Otto Glasser, 2050 East Ninety-Third Street, Cleveland, Ohio.

THE offer of Professor S. Smiles and Professor A. J. Allmand to found a medal at the University of London to commemorate the services rendered to King's College and to chemical education by Professor John Millar Thomson, LL.D., F.R.S., has been accepted with thanks by the university. Professor Thomson first became a member of the staff of the department of chemistry at King's College in 1871, and retired in 1914, after having served for twenty-seven years as Daniell professor and head of the department of chemistry. The medal will be known as the John Millar Thomson Medal for Chemistry and will be awarded annually to the student of King's College who most distinguishes himself in the final year of the special honors course in the department of chemistry.

SCIENTIFIC EVENTS

THE FARADAY CENTENARY

THE following account is given by the London *Times* of arrangements being made by the Royal Institution for the celebration in September, 1931, of the discovery by Michael Faraday of electromagnetic induction, in which lies the origin of the dynamo and which is the starting point of the utilization of electric power for the purposes of man.

The day of the discovery was August 29, 1831. On that day Faraday, as his diary shows, working in his laboratory at the Royal Institution, wound two coils of wire on to opposite sides of a soft iron ring, connected one coil to a battery and the other to a galvanometer, and at the "make" and "break" of the battery circuit observed the deflections of the galvanometer connected in the other circuit. From this simple experiment and the variations made in it by Faraday in subsequent trials has grown in the past one hundred years the science of electrical engineering. The Royal Institution, in a preliminary announcement of the proposed celebrations, says: "No other experiment in physical science has been more fruitful in benefit for mankind. August 29, 1931, is, then, the centenary of one of the great events in the history of the world."

The Royal Institution and the Institution of Electrical Engineers have joined forces in making plans for the celebrations, and a number of other societies and organizations are cooperating. The Royal Society will entertain the delegates; the British Association has arranged the dates for its centenary meeting in London, also in 1931, to coincide with the Faraday celebrations; the Federal Council for Chemistry will participate in the arrangement of a Faraday Exhibition, for Faraday's chemical researches—his isolation of benzene and his establishment of the laws of electro-chemistry—are hardly less remarkable than his purely electrical discoveries, and government, university and scientific interests have joined in offering their assistance to make the celebrations worthy of the occasion.

The provisional program includes a Faraday Commemorative Meeting at the Queen's Hall on Monday, September 21, 1931, at which addresses will be given on Faraday's work. On Tuesday the summer meeting of the Institution of Electrical Engineers, with joint conference of allied associations, will be held; on Wednesday morning there will be the opening of the Faraday Exhibition to the public at the Albert Hall, and in the evening the opening meeting of the British Association will be held at the Central Hall, Westminster.

Faraday kept a careful diary, in his own hand, of all his experimental work, which was bequeathed to the Royal Institution and for over sixty years has been its most treasured possession. The Royal Institution has resolved to publish the diary in full. It is intended to have two or more of the six or eight volumes in which the work will ultimately be completed ready by September, 1931. It will be issued by Messrs. G. Bell and Sons, Limited, York House, Portugal-street, W.C.2.

EXPLORATIONS IN AFRICA

A WIRELESS to the New York *Times* dated from London states that data and relics of the African explorations of David Livingstone and Sir Henry Stanley have been found by Colonel Charles Wellington Furlong, an American explorer, artist, author and lecturer, who arrived in London on August 13 *en route* to the United States following a seven months' expedition into the heart of Africa.

While the chief purposes of the expedition, which covered 7,000 miles in Kenya, Tanganyika, Uganda, the Belgian Congo and the West Nile Provinces, were an ethnological study of African tribes and big game hunting as well as a study of political, economic and social conditions, Colonel Furlong was desirous of finding whatever traces remained in Africa of Livingstone and Stanley.

In a Belgian Congo village he found Chief Godoy, a son of Chief Matibu, the most important native associate of Sir Henry Stanley, from whom he learned many facts of considerable interest about Stanley and the others of his expedition and about Chief Matibu himself. Chief Godoy had carefully preserved many of his father's relics, including his favorite spearhead, carried when he was with Stanley, a remarkable letter of appreciation written to Chief Matibu by Lady Stanley in 1911, an elaborate gold headdress which she sent therewith and a bracelet given to Chief Matibu by Sir Henry. All these things Colonel Furlong bought from Chief Godoy.

"Precious as they were to him," said Colonel Furlong, "I was able to convince him that in some museum they would better preserve for posterity the record of Chief Matibu's association with Stanley, whereas in the jungles they could easily be lost. He sold them on the condition that I return to him framed photographs of Lady Stanley's letter and other relics to be hung on the walls of his hut where all the natives could admire them."

In South Mombasa Colonel Furlong located a native about ninety years of age who is the only surviving member of Livingstone's expedition. He was one of five who went into the interior with Livingstone when he died and bore on his shoulders the explorer's mummified body from the jungles of Africa. Colonel Furlong spent six hours getting this man's story, the details of which, as well as the Stanley data, he intends to publish on his return to the United States.

THE FOURTH WORLD POULTRY CONGRESS

THE Fourth World Poultry Congress, which was opened at the Crystal Palace by the Duke of York on July 22, closed on July 30. The London *Times* reports that during the congress 2,400 delegates and members registered from 61 countries, and about 80,000 people passed the turnstiles.

At the final assembly of delegates and members, presided over by Mr. F. C. Elford (Canada), president of the World Poultry Science Association, an address was sent to the King expressing appreciation of the manner in which the government and departments of state had organized the congress and exhibition, and of the hospitality accorded to them.

A resolution was also adopted thanking the Governments of Great Britain and Northern Ireland and the Ministry of Agriculture and Fisheries for the welcome accorded to the delegates and their admiration of the organization of the congress and exhibition. Another resolution thanked the World's Poultry Science Association, which initiated the congress; the congress officials, with special acknowledgment of the services of Mr. Percy A. Francis, director, and Dr. Wilkins, secretary; the committees and the hosts on various excursions, and to Mr. H. J. Buckland, general manager of the Crystal Palace.

Several resolutions were submitted from the various conference sessions. The education and general section passed a resolution, by seventeen votes to seven, "that the various government departments and egg-laying competition committees conducting egg-laying competitions be asked to consider the advisability of introducing the 2 oz. standard from the beginning of the competition." This was amended by the addition of the metric equivalent, 56.7 grams, and adopted.

Another resolution, adopted unanimously by the education and general section, was "that during the next three years the council of the World's Poultry Science Association draw up, with the assistance of sub-committees, universal standards for all the different breeds of poultry, such standards to be submitted to the next World's Poultry Congress." The feeling of the assembly was that although international standards represented an ideal to which all would subscribe, it was not sufficiently practical to justify taking up the time of the next congress, and the resolution was not adopted.

The diseases section unanimously recommended "That the attention of the various governments be drawn to the danger of the importation of 'Newcastle' (or 'Ranikhet') disease, with a view to suitable measures being taken for its exclusion and control in each country." On the suggestion of Dr. te Hennepe (Holland) the name "pseudo fowl pest" was preferred to "Newcastle" disease, and with this amendment the resolution was adopted.

The economics section resolved that it was a matter of urgent importance that each government should include poultry statistics in every agricultural census. This was adopted without discussion.

The economics section also adopted a resolution, on the motion of the Dutch delegates, expressing the view that all eggs cold stored in any country should be stamped with an internationally agreed mark. Amendments were submitted to include gas-stored as well as cold-stored eggs. In this form the resolution was carried. The assembly also adopted a resolution asking the International Institute of Agriculture at Rome to convene a conference to discuss an international scheme for identifying stored eggs.

HONORARY DEGREES CONFERRED BY LEHIGH UNIVERSITY

Lehigh University conferred at the commencement the honorary degree of doctor of engineering on Mr. Thaddeus Merriman, '97, son of the late Mansfield Merriman, who was professor of civil engineering at Lehigh for almost thirty years, and the degree of doctor of science on Commander Nicholas H. Heck, '03, chief of the division of terrestrial magnetism and seismology of the United States Coast and Geodetic Survey.

In presenting Mr. Merriman to President Richards for the degree, Professor Ralph J. Fogg, head of the department of civil engineering, gave the following outline of his career and accomplishments:

Thaddeus Merriman, whose noteworthy accomplishments and engineering skill have gained for him the distinction of being one of America's chief authorities on municipal water supply, is presented for the honorary degree of doctor of engineering.

Graduating from Lehigh in 1897 with the degree of civil engineer, Mr. Merriman received his early experience on geological reconnaissance work in Pennsylvania and surveys for the United States, Nicaragua and Isthmian Canal Commissions.

Since 1902 he has been in continuous service in the water works field, starting with the Jersey City Water Supply Company as assistant engineer on the Boonton Dam, and later as division engineer with the East Jersey, Passaic and Acquackanonk Water Companies. He has served on the engineering staff of the Board of Water Supply of the City of New York for twenty-five years, receiving successive promotions to his present responsibility as chief engineer, which position he has filled since 1922. Under his direction was prepared the plan for a new water supply from the upper tributaries of the Delaware River; the estimated cost of this project, including the delivery of water into New York City, being over three hundred million dollars.

In 1918 Mr. Merriman was called to Greece for the purpose of investigating the proposed water supply for the city of Athens. Last fall he was signally honored by being made chairman of the Board of Engineering Review of the Metropolitan Water District of Southern California.

It is interesting to recall that on Founder's Day, seventeen years ago, the honorary degree of Doctor of Laws was conferred on Mr. Merriman's father, Mansfield Merriman, Lehigh's great writer and teacher of engineering.

President Richards's citation follows:

Thaddeus Merriman, loyal son of Lehigh, distinguished in service with the U. S. Nicaragua Canal Commission, with the U. S. Isthmian Canal Commission and with the Board of Water Supply of New York City, now chief engineer of the latter, contributor to the science and practice of hydraulics and water supply engineering as

notably exemplified in the design and construction of the Catskill Water Supply System.

Commander Heck was presented to President Richards for the degree of doctor of science by Professor C. C. Bidwell, head of the department of physics, with the following brief sketch of his achievements:

Commander Heck is a graduate of Lehigh University of the Class of 1903. He has achieved high distinction in his chosen field and is a recognized authority on seismology and terrestrial magnetism. He is the author of many scientific papers and publications of the Coast and Geodetic Survey. Among these are the following titles: "Radio Acoustic Method of Position Finding in Hydrographic Surveys," "Earthquake History of the United States," "Report on Network of Earthquake Observations of Countries bordering the Pacific," "Values of the Velocity of Sound for Echo Soundings in the Pacific Ocean," "Oceanography and Seismology in the Pacific Region," etc. It is a privilege to present to you Commander Heck for this degree.

In conferring the degree President Richards said:

Nicholas Hunter Heck, loyal son of Lehigh, recognized for distinguished service with the U. S. Coast and Geodetic Survey as commander of the schooner *Matchless* and of the steamer *Discovery*, and as chief of the Division of Terrestrial Magnetism and Seismology, contributor to the science of deep sea sounding, the compensation of the magnetic compass and the study of earthquakes.

SCIENTIFIC NOTES AND NEWS

THE Mueller Memorial Medal of the Australian Association for the Advancement of Science was awarded at the recent meeting at Brisbane, which was held from May 28 to June 4, to Sir Douglas Mawson for his contributions to Australian geology, associated with which are his achievements in geography and exploration. The first Liversidge Research Lecture under the bequest from the late Professor A. Liversidge was delivered by Professor N. T. M. Wilsmore, of the University of Western Australia, the title of the lecture being "Chemical Research and the State." At this meeting it was decided to change the name of the association to "The Australian and New Zealand Association for the Advancement of Science."

THE Moxon gold medal of the Royal College of Physicians, London, awarded every third year to the person who is deemed most to have distinguished himself by observation and research in clinical medicine, has been awarded to Dr. Frederick Parkes Weber. The Weber-Parkes prize and medal, awarded every third year for work on the etiology, prevention, pathology or treatment of tuberculosis, has been awarded to Professor S. Lyle Cummins.

THE honorary gold medal of the Royal College of Surgeons, London, has been awarded to Mr. R. Lawford Knaggs, in appreciation of his services to the museum, more especially in preparing a catalogue of and revising the Strangeways collection of specimens illustrating arthritis.

THE special gold medal awarded by the Congress to Colonel Charles A. Lindbergh, to commemorate his achievements in the advancement of the science of aviation, was presented to him by President Hoover on August 15.

IN appreciation of the service given to the University of California Medical School by Dr. William Palmer Lucas, for several years head of the department of pediatrics, who retired at the close of the academic year, members of his staff recently held a banquet and presented him with a gold watch purchased with contributions from students of every one of the seventeen years.

"As a token of appreciation of his outstanding civic services," the citizens of Tallulah, Louisiana, have presented to B. R. Coad, in charge of the cotton-insects division of the Bureau of Entomology, having its headquarters in their town, a motion-picture camera and projector. This presentation was made at a meeting of the Business Men's Luncheon Club of Tallulah, of which Mr. Coad recently was elected an honorary member.

THE Poultry Science Research Prize of $100, which is awarded annually to the member of Poultry Science Association who publishes the most outstanding piece of research contributing to the furtherment of the poultry industry, has been awarded to Dr. F. A. Hays, of Massachusetts, for his work "Inbreeding in Relation to Egg Production." Honorable mention was given the paper of Dr. D. C. Warren, of Kansas, on "The Inheritance of Rhode Island Red Chick Down-Color Variations and their Relation to Color Variations in Adult Plumage," published in the November 15, 1929, issue of the *Journal of Agricultural Research*, and to the paper by Hendricks, Lee and Titus, "Early Growth of White Leghorns," published in *Poultry Science* for September 1, 1929. The check for $100 was presented to Dr. Hays at the annual banquet of the Poultry Science Association by J. Holmes Martin, secretary-treasurer of the association.

THE Harveian oration of the Royal College of Physicians in 1931 will be delivered by Dr. Robert

Hutchison. The Bradshaw lecture will be given by Dr. J. S. Fairbairn.

THE Council of the City and Guilds of London Institute has conferred the distinction of fellow of the institute upon the following: F. M. Denton, A. H. Dykes, W. M. Heller, E. M. Rich and F. F. Renwick. The fellowship is conferred by the council upon those who, having obtained the associateship of the institute and spent at least five years in actual practice, produce evidence of having done some original and valuable research work or of having otherwise contributed to the advancement of the industry in which they are engaged.

MR. R. W. TRULLINGER, assistant in experiment station administration and senior agricultural engineer of the Office of Experiment Stations, was elected president of the American Society of Agricultural Engineers at the recent annual convention at Moline, Illinois.

PROFESSOR LEWIS ROBERTSON SUTHERLAND has resigned from the chair of pathology at St. Andrews University.

THE following officers of the Royal College of Surgeons, London, have been elected for the ensuing year: *President,* Lord Moynihan; *Vice-presidents,* Mr. C. H. Fagge and Mr. R. P. Rowlands; *Physiological curator,* Mr. R. H. Burne; *Pathological curator,* Mr. C. F. Beadles; *Honorary curator of Odontological Collection,* Sir Frank Colyer; *Honorary curator of the Historical Collection,* Mr. C. J. S. Thompson.

PROFESSOR OWEN THOMAS JONES, of Trinity College, professor of geology and mineralogy at the Victoria University of Manchester, has been elected to succeed Professor J. E. Marr, of St. John's College, who will retire from the Woodwardian professorship of geology at the University of Cambridge on September 1.

AT the University of Cambridge Dr. J. M. W. Morison has been appointed to the university chair of radiology, tenable at the Cancer Hospital; Dr. H. D. K. Drew to the university readership in organic chemistry, tenable at East London College; Sir Arthur Evans, fellow of Brasenose College, Oxford, to the Frazer lectureship in social anthropology for the academical year 1930–31, and the appointments committee of the Faculty of Agriculture and Forestry has appointed H. E. Woodman, of Downing College, university lecturer in agricultural chemistry for three years from October 1, 1930, and W. K. Hubble, of Downing College, university demonstrator in agriculture for a like period. With the concurrence of the Ministry of Agriculture and Fisheries, Dr. Marshall was appointed director of the Animal Nutrition Institute from August 1.

DR. H. W. GILLETT, director of Battelle Memorial Institute, announces the following additions to the staff: Dr. O. E. Harder, assistant director; Dr. C. H. Lorig, metallurgist; Samuel Epstein, metallurgist, and L. H. Grenell, metallurgist. Dr. Harder has been professor of metallography at the University of Minnesota during the past eleven years and was also engaged in consulting work. He had previously been with the Portland Cement Association, the N. K. Fairbanks Company and the Mellon Institute. Dr. Lorig came directly from Drexel Institute, where he was professor of mechanical engineering in charge of their metallurgical courses, and will study foundry and general metallurgical problems at Battelle. He has had experience with the Wisconsin Steel Company, the Wisconsin Appleton Company, the French Battery Company and the Laddish Drop Forge Company. Mr. Epstein has been research metallurgist for the Illinois Steel Company and metallographer at the U. S. Bureau of Standards and will have charge of a research on the embrittlement of steel—one of the sponsored projects of Battelle. Mr. Grenell has been with the Ingersoll-Rand Company, the Bureau of Mines, the Bureau of Standards and the Frigidaire Corporation. He will study the production and utilization of metal foils—another sponsored project.

DR. FRED N. BRIGGS, of the office of cereal crops and diseases of the U. S. Department of Agriculture at Berkeley, California, has been appointed assistant professor of agronomy at the University of California and assistant agronomist of the Agricultural Experiment Station.

THE Frederick G. Donnan fellowship in chemistry, tenable for three years at the Johns Hopkins University, has been awarded to Mr. Alkin Lewis, of King's College, London.

DR. J. L. COLLINS, assistant professor of genetics at the University of California, has been appointed geneticist for the experiment station of the Association of Hawaiian Pineapple Canners, University of Hawaii, and is now in Honolulu.

THE *Experiment Station Record* reports that Dr. E. C. Stakman, professor of plant pathology and plant pathologist of the University of Minnesota, has been granted leave of absence to aid in organizing biological research in connection with a 50,000-acre rubber plantation in Liberia, which is being established by an American tire company. Arthur F. Verrall, instructor in plant pathology and assistant plant pathologist and botanist, accompanied him on this trip and

is expected to remain for a longer period to oversee the experimental work of the company until it is well under way.

Dr. Samuel J. Holmes, professor of zoology at the University of California, who has been traveling in Europe during the past year, has returned to Berkeley.

Dr. Robert K. Nabours, who is spending the year as associate in the department of genetics of the Carnegie Institution at Cold Spring Harbor, will return to the Kansas Agricultural College on September 1.

Dr. Alexander Silverman, head of the department of chemistry of the University of Pittsburgh, sailed on August 21 for Europe. He will visit educational and research institutions in France, Holland and Belgium, and will attend the Tenth International Congress of Industrial Chemistry at Liége, Belgium, during the week of September 7, as a delegate from the American Ceramic Society, and the tenth International Union of Pure and Applied Chemistry, also at Liége, during the week of September 14, as one of fifteen delegates from the National Research Council and the National Academy of Sciences.

DISCUSSION

RELATIVE LENGTH OF PLEISTOCENE GLACIAL AND INTERGLACIAL STAGES

In a report by R. T. Chamberlin[1] dealing with fluctuations of sea-level as controlled by glaciation, an estimate is presented of the percentage of the Pleistocene glacial epoch involved in glacial as compared with interglacial stages, and also an estimate of the percentage of time in a glacial stage in which the ice-sheets were at about their greatest extent. The estimates were given him by ten American glacialists who had had considerable experience in the study of glacial deposits in North America. In this composite estimate the glacial stages were given only one fourth the length of the interglacial stages, or 20 per cent. of the time involved in the Pleistocene glacial epoch. It was estimated by seven of the ten glacialists (three failing to give estimates) that the ice-sheet was at about its greatest extent for only one fifth of a glacial stage, or 4 per cent. of the glacial epoch, being in process of advance and retreat for four fifths of the glacial stage or 16 per cent. of the glacial epoch.

It now appears from a study of the distribution of moraines developed in the Wisconsin stage of glaciation that there was very little difference in the area covered by the ice-sheet throughout the greater part of that glacial stage, or from the time of the outermost Early Wisconsin moraine, the Shelbyville, to the time of the outermost Late Wisconsin moraine, the Port Huron. By extensive westward growth in Middle and Late Wisconsin time beyond the limits reached in Early Wisconsin time, the shrinkage shown by the exposed part of the Early Wisconsin deposits in the south part of the area was counterbalanced by the greater westward extent in higher latitudes. This shifting seems to have been due to a greater nourishment on the western side of the ice-sheet rather than to a change to higher temperature. The southern part became undernourished and showed a corresponding shrinkage. In view of these conditions it is probable that not less than 60 per cent. of the Wisconsin stage should be allotted to the culmination, and 20 per cent. each to the advance and the retreat of the ice-sheet.

From a study of the recession of Niagara Falls by Spencer, Taylor and others[2] it appears that the Port Huron morainic system, which marks the limits of the Late Wisconsin drift, was formed some 25,000 to 30,000 years ago. It also appears from a study of the Falls of St. Anthony on the Mississippi by Winchell, Grant and especially by Sardeson[3] that the outlet of the Glacial Lake Agassiz did not shift to Hudson Bay until some 8,000 to 10,000 years ago. This being the case the Wisconsin ice-sheet persisted in central Canada to within 10,000 years of the present time. It also appears that a period of about 15,000 years is involved in the retreat from the Port Huron moraine to the breaking up of the ice-sheet in central Canada. If then this retreat represents 20 per cent. of the time involved in the Wisconsin stage of glaciation, the length of this glacial stage is some 75,000 years and its beginning about 85,000 years ago. If then the culminating phase involved three fifths of the entire glacial stage, it endured some 45,000 years.

Estimates of the relative ages of the Kansan, Illinoian and Wisconsin drifts are based mainly on the erosion each has suffered. The Kansan drift appears to have been eroded to such a degree that an average of fifty feet of material would be required to restore the original surface as left by the withdrawal of

[1] Rollin T. Chamberlin, "Geological Interpretation of the Coral Reefs of Tutuila, American Samoa," pp. 145–178, Publication 340, Carnegie Institution of Washington, 1924.

[2] See Niagara Folio, U. S. Geological Survey.

[3] See St. Paul-Minneapolis Folio, U. S. Geological Survey.

the Kansan ice-sheet. The Illinoian drift is sufficiently eroded to require about fifteen feet for its restoration. The Early Wisconsin drift seems to need only five feet and the Middle and Late Wisconsin still less. The Iowan drift is too thin and patchy to furnish a basis for measurement of its erosion. The Nebraskan drift is so completely covered by the Kansan that its degree of erosion can not well be determined. That it is much older than the Kansan drift is known, however, from the development of gumbotil on its surface prior to the burial beneath the Kansan drift, and also by deep leaching and oxidation. On the basis of relative erosion the Illinoian drift appears to be about three times as old as the Early Wisconsin drift. Taking the estimates given above, the outer part of the Early Wisconsin drift is about 70,000 years old, in which case the age of the outer part of the Illinoian can be put at about 200,000 years. The close of the Illinoian glacial stage, however, may be between 150,000 and 175,000 years ago. The age of the Kansan drift appears to be more than a half million years and may reach three fourths of a million. The Nebraskan is probably a million years old.

There is no question of the occurrence of long interglacial intervals of relatively warm climate between the Nebraskan and Kansan glacial stages and between the Kansan and Illinoian stages. The latter appears to be more than four times the length of the Wisconsin glacial stage and thus to bear out the estimate made by glacialists and reported by Chamberlin. But there seems need for a recalculation of interglacial intervals between the Illinoian and Wisconsin glacial stages. The place and rank of the Iowan glaciation are also of importance in this connection.

An early interpretation that the Iowan is a distinct glacial stage falling between the Illinoian and Wisconsin glacial stages is still stoutly adhered to by several glacialists, but the present writer and also T. C. Chamberlin have expressed the view that the Iowan may stand as the western or Keewatin phase of the same glacial stage as the Illinoian and have a similar relation to it that the Late Wisconsin drift has to the Early Wisconsin.

If the Iowan is a distinct glacial stage, falling between the Sangamon and Peorian interglacial stages, it should fill a considerable part of the interval separating the Illinoian and Wisconsin stages and thus leave a very brief interglacial stage between it and the Illinoian stage, as well as between it and the Wisconsin stage. As a separate glacial stage the Iowan would probably embrace at least 30,000 years, the time estimated for the advance and disappearance of the Wisconsin ice-sheet. Taking the above estimate that the Illinoian glaciation ended 150,000 to 175,000 years ago and that the Wisconsin glaciation began about 85,000 years ago, there would be an interval of between 65,000 and 90,000 years between these two glacial stages. If the Iowan glaciation occupied 30,000 years in the midst of this interval, there would remain 35,000 to 60,000 years to be divided between the Sangamon and Peorian interglacial stages. In case of so brief interglacial intervals it may be more consistent to regard the Illinoian, Iowan and Wisconsin as a triple glaciation occupying the 200,000 years since the culmination of the Illinoian glaciation, and consider the Sangamon and Peorian times of slightly increased warmth between times of low temperature, causing a marked retreat of the ice border but not having the duration or degree of warmth of a true interglacial stage. This raises the question whether the ice had disappeared in the Sangamon or the Peorian interval to as great degree as at the present time in the northern part of the North American continent. The data at hand do not seem to be decisive on this matter.

It is of interest in this connection to note that Dr. Paul Woldstedt, a member of the Prussian Geological Survey, after spending a summer in the study of the North American drifts, in order to clear up correlations with the drifts of Europe, on which he had made extensive studies, has placed the Iowan drift in the midst of the European third interglacial stage in his recent book "Das Eiseitalter."[4]

The present writer, as already indicated, favors the reference of the Iowan drift to the same glacial stage as the Illinoian and places it near the close of the third glacial stage, about as the Late Wisconsin came in the last glacial stage. The combined Illinoian-Iowan, it is thought, may have covered a period similar to that of the Wisconsin, about 75,000 years, from say 210,000 down to 135,000 years ago, leaving an interval of 50,000 years between its close and the beginning of the Wisconsin stage. On this interpretation, as on that of a separate Iowan glaciation, it is an unsettled question whether the northern part of the North American continent was deglaciated to the present degree in this interval. The well-known Toronto interglacial beds suggest a warmer climate than the present, but it is not certain that they fall in this interglacial stage. They may prove to belong in the second, or Yarmouth, interglacial stage.

The Iowan drift displays a conspicuous pebbly concentrate on its surface, developed before the surface coating of loess was laid down. The development of this concentrate the present writer is disposed to refer to the Sangamon interval and consider a somewhat full equivalent. But it is thought by those geologists who are putting the Iowan in a separate and

[4] See table on page 292.

later glacial stage than the Illinoian that this concentrate was formed in a very short time, largely by wind action. As matters now stand, there seems need to determine whether or not this concentrate was formed in a short time. The mere declaration that it was formed rapidly is not to be taken as decisive, even if several geologists unite in the declaration.

The present writer is also skeptical of an interpretation which restricts the glaciation of one stage to the eastern part of the continent and of a succeeding stage to the central part of the continent, for in the Nebraskan, Kansan and Wisconsin stages there was glaciation over both the eastern and the central part. It thus seems more natural for the Illinoian of the eastern part to have its equivalent in the Iowan of the central part.

In the above estimates it was calculated that if the third or Illinoian glaciation covered only the eastern part of the continent it may have lasted only about 50,000 years, or from 210,000 down to 160,000 years ago. But if it covered the central as well as eastern part of the continent and embraced the Iowan it is likely to have lasted 75,000 years, or down to 135,000 years ago.

Summing up the matter of the relative proportion of time involved in the Pleistocene glacial and interglacial stages, it appears that fully 75 per cent. of the last 200,000 years has been under glacial conditions, but that prior to this the interglacial conditions were prevalent for at least 75 per cent. of the time. If then the entire Pleistocene period embraces a million years, the glacial conditions were prevalent for about 300,000 years, and the interglacial conditions for about 700,000 years, of which some 50,000 years, falling in the Sangamon and Peorian intervals, may not have been as warm as the present.

FRANK LEVERETT

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THE OXYGEN CONSUMPTION OF NERVE DURING ACTIVITY

THE recent article in this journal by Professor Winterstein[1] dealing with the above question has just come to my attention. The increase in oxygen consumption, over its resting value, of a nerve, stimulated by induction shocks, has been regularly interpreted as measuring the active metabolism of conduction. Winterstein presents reasons for considering this excess oxygen as the result largely or entirely of a local response to an artificial stimulus, and therefore unrelated to the normal events of conduction. Some of the points he makes are as follows. (1) When the region of the nerve actually stimulated is in the respiration chamber, the resting oxygen consumption is increased up to 400 per cent.; but when the excited region is excluded and the conducting trunk studied only a 14 per cent. increase or, in his own experiments, no increase is observed. (2) The extra oxygen consumption of the frog's spinal cord is much greater on direct electrical stimulation than when excited *via* a nerve—even when strychnized. (3) After stimulation of a dog-fish spinal cord no longer evoked muscular responses an excess oxygen consumption was still to be obtained. (4) The oxygen consumption of a snake's vagus nerve was not changed when the central and peripheral connections were severed, although normal spontaneously passing impulses were abolished.

It may not be amiss to point out here some possible answers to these points other than that suggested by Winterstein, as well as to indicate some of the important evidence that can not, apparently, be reconciled with his view. (1) It seems unwise to express the oxygen consumption of activity as a percentage of the resting, since much evidence indicates that the variables are independent. The resting metabolism is largely a carbohydrate oxidation or glycolysis, the active surely not. The former depends on nerve fibers, sheath, connective tissue, etc., while the latter is presumably limited to the axones themselves; and these structural elements vary widely from species to species. As a matter of fact, for dog-fish lateral line nerve the percentage increase in respiration on activity as determined by Parker, stimulating outside the experimental chamber, and Fenn, stimulating within, was almost identical. For the American green frog, Parker found a 14 per cent. increase; Fenn a 26 per cent. increase, and I (1930),[2] also stimulating within the chamber, a 35 per cent. increase. For the European frog I found for continuous stimulation a 100 per cent., for intermittent stimulation a 300–400 per cent. increase. The absolute increase in all cases, allowing for temperature, etc., was roughly the same —the values obtained when the stimulus occurred inside the chamber were *not* higher than when it was excluded.

(2) It is doubtful if even on direct electrical stimulation of the spinal cord all nerve cells are activated, and also glia and other cells may be stimulated or injured. The increased oxygen consumption is determined by the sum of all. Stimulation of an afferent nerve not only will fail to affect non-nervous tissues, but also there is ample evidence that, even after strychnine, such afferent impulses will not reach all cells and of those reached not all will be excited—some are actually inhibited. The reflexly evoked

[1] H. Winterstein, SCIENCE, 71: 641, 1930.

[2] R. W. Gerard, *Proc. Soc. Exp. Biol. and Med.*, 27: 1052, 1930.

activity could hardly equal the effects produced by passing a current through the cord itself.

(3) Similarly with the dog-fish cord. Absence of external response does not guarantee absence of conduction and responses all through the cord itself. There is another point in connection with (2) and (3) that will be returned to.

(4) The number of fiber-impulses normally passing along a vagus nerve is unknown, but compared with those evoked by tetanization with maximal stimuli is probably insignificant. The impulses continuously passing to skeletal muscle to maintain tone are, as judged by tension, less than 1 per cent. of the maximum motor impulses possible (neglecting afferent fibers). The elimination of such an amount of activity in the vagus could not be detected.

In favor of the accepted view of the functional significance of the extra oxygen consumption of activity may be mentioned the following: (a) The extra oxygen consumption agrees quite well with the extra heat production of frog nerve—although in heat measurements the region stimulated is several centimeters removed from that observed, and also the observed heat production is abolished when the nerve is blocked between the region stimulated and that lying on the thermopile. (b) Extra heat production and respiration last 10 to 30 minutes after all stimulation has ceased. (c) During equilibration, and in other conditions, the extra heat production, oxygen consumption and action potentials vary concomitantly. (d) These same changes reach a maximum with increasing stimulus strength and then do not further increase until much stronger shocks are used. This is true for oxygen consumption when the stimulus is applied within the chamber, *i.e.,* oxygen consumption does not parallel shock strength.

A control experiment to fully test the stimulus effect was reported in my initial paper (1927)[3] on this subject, and has recently been repeated by Mr. Chang, working with me. Two sets of nerves of the same frogs are mounted in the usual way on the electrodes of the two chambers of a differential manometer. On one side, the nerve trunks are cut a few millimeters from the electrodes, leaving the ends in place. On this side, then, the effect of stimulation with very little conduction is obtained, on the other stimulation plus full conduction. In two trials the increased oxygen consumption on stimulation with maximal shocks was 50 times greater on the intact side than on the cut one.

A final word on the effects of stimulation. Conduction involves, of course, successive stimulation of regions along the nerve. A stimulus, in order to just initiate this reaction, need only reach a threshold value over a microscopic region. As an electric current is increased in strength it spreads over a larger region and is able to cause excitation over this region, aside from conduction. When still more intense, electrolysis effects must begin to become serious and many secondary oxidations ensue. It must certainly be possible with strong electrical stimuli to obtain an increased oxygen consumption quite independently of the physiological response of the tissue. But with just adequate stimuli the local effect would seem, from the evidence presented, to be negligible. Professor Winterstein's failure to detect an increased oxygen consumption during activity when the stimulation took place outside the chamber must be explained, I believe, by injury to the nerve or inadequate sensitivity of the apparatus.

R. W. GERARD

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[3] R. W. Gerard, *Am. Journ. Physiol.*, 82: 381, 1927.

SETIGEROUS CYSTS IN THE EARTHWORM

IN the course of the routine dissection in the laboratory of Lumbricus, a very curious abnormality was discovered which was quite new to the laboratory staff and whose significance is not yet evident. This note is made in order to call it to the attention of others who may have observed it or who may be able to enlighten the author.

In the posterior portion of the specimen, which was of large size, obtained through the General Biological Supply House, in the segments from the eighth to the twenty-second from the posterior extremity, at least thirty-four conspicuous cysts were discovered. They were of oval form and of dirty, yellowish brown to dark purplish brown color and seemed to be lying loose in the coelom. Under ordinary low power there was no evident broken edge to indicate an attachment to the body wall, and some of the cysts dropped out simply on inverting the split end of the worm under water. In some segments as many as three cysts occurred.

Upon teasing the cysts with dissecting needles, it was found that they contained large numbers of setae of varying sizes. Some of the setae were nearly 1.5 mm in length, others only about .5 mm. Upwards of forty setae occurred in a single cyst. In one large cyst, the setae lay for the most part closely packed together approximately parallel to the long axis of the cyst. In most cases the setae were perfectly normal in form and appearance, but occasionally the chitin appeared to be irregularly split and fissured. This may have been an artifact. Besides the setae, in many of the cysts there were numerous nematodes of undetermined species. Usually there were as many as a dozen in a single cyst. Besides the adult worms

there were also found bodies which looked like embryos.

The material of which the cysts were composed was rather scanty. Teasing revealed only a coarsely granular material the cellular nature of which could not be clearly distinguished. The granules were of irregular size and of varying degrees of transparency. Some appeared quite black, others were brownish or colorless.

The setigerous sacs seemed to be normal in the segments in which the cysts occurred, and in many of the segments the nephridia seemed to be perfectly normal.

No one of the laboratory staff had ever encountered these cysts, and it is difficult to see what they mean. Do the setae in the cysts represent a response to the presence of the parasites? Do they represent bits of the setigerous glands which have "run wild" like tumors?

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AUTO-TRANSPLANTED GASTRIC POUCH FUNCTIONING FOR FIVE YEARS

THIS note is to record the interesting fact that an auto-transplanted pouch of the fundic portion of the stomach functioned for five years. The pouch was transplanted beneath the mammary gland in a female dog in January, 1925. The fact that the pouch secreted following the ingestion of a meal was recorded by Ivy and Farrell[1] in November, 1925, the animal being demonstrated in Cleveland at the meetings of the American Physiological Society[2] in December, 1925. This fact proved the existence of a humoral mechanism for gastric secretion. Observations on the motility of the pouch have been recorded,[2] the most important observations being that when the stomach proper manifested "hunger contractions" the pouch also manifested "hunger contractions," and that the ingestion of food not only inhibited the hunger contractions of the stomach, but also those of the pouch, which demonstrated that a humoral mechanism plays a rôle in the causation of the hunger motility of the stomach. These observations have been repeated and confirmed at intervals on this particular dog for five years. The secretory and motor functions of the pouch continued until the animal contracted an infectious jaundice and pancreatitis which resulted in death in June, 1930. A histological study of the pouch immediately after death revealed the same partially atrophic changes recorded in a previous article.[1]

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SCIENTIFIC BOOKS

Astronomy. By R. H. BAKER. xix + 521 pp. Van Nostrand Company, 1930.

A TEXT-BOOK for introductory college courses in astronomy. The author, who is professor of astronomy at the University of Illinois, has purposely eliminated mathematics where practicable, and does not presuppose any considerable knowledge of physics. With these limitations the author has succeeded remarkably well in giving a picture of the science at the present day.

This book was needed. Many good text-books on astronomy have recently appeared. Yet some of them are too easy for a course of three hours a week during a whole year, and some are too difficult. Professor Baker's book is just what one requires for such a course.

In some respects his desire to avoid mathematical treatment may have been too great. The sections which deal with solar and lunar eclipses, for instance, do not contain any algebraical formulae at all. But in order to explain the phenomena some recourse to "algebra in words" was necessary. Would not even mathematically ill-equipped students prefer some simple formulae?

The book is beautifully printed. The illustrations are well chosen and well reproduced. Figures 10.25, 10.25A on p. 418 are obviously misplaced. One wonders what these pictures of constellations have to do with "the importance of radiation pressure," the subject of the corresponding section.

Some misstatements occur in the section on the variation in the speed of the earth's rotation (p. 52). It is stated that meridian transits of *stars* exhibit fluctuations due to irregularities in the earth's rotation. This is obviously confusing, as they are just the readings on the earth-clock. We further read: "From 1660 to 1790 the earth ran fast; then it ran slow until 1898 when it became fast again." Fast and slow should be interchanged. There is an amusing misprint in the preceding sentence: ". . . sudden changes in the period of rotation, at times as much as 0.ˢ00 . . . [occur]."

Concluding the section on tides in the solid earth (p. 173), the author states, erroneously of course,

[1] *Am. J. Physiol.*, Volume 74, 1925.

[2] *Am. J. Physiol.*, Volume 76, 1926.

that the earth tides keep in step with the fluid tides of the ocean.

A few more remarks of this kind could be added. But they are in general of minor importance and can be made of every book in which such a wealth of new material has been digested. In fact, the book is exceedingly accurate. The definitions are very carefully chosen, and even where others have usually gone wrong, the book gives correct statements. Typographical errors are also very rare.

Astronomical instruments are briefly treated. Sextant, theodolite, zenith telescope, heliometer are not even mentioned. Apparently the author chooses to emphasize results more than methods of research.

The book is well up-to-date. Pluto, discovered so recently at the Lowell Observatory, is incorporated as the ninth principal planet. Justice is done to the importance of astrophysical research by devoting an admirable 40-page chapter to the constitution of the stars. In this chapter we find a very clear picture of what very recent developments have contributed to our knowledge of the make-up of stars. The following two chapters on the galactic system and exterior galaxies are also up to the minute.

An unusual subject in a book on astronomy is the earth's atmosphere, to which some considerable attention is paid, in particular to illustrate analogies with the sun and the planets.

The author has all sorts of illustrations at his disposal to make facts of exact nature clearly understood: "Everywhere in its interior the intensely hot star is kept inflated like a tire but with far less immediate danger for a blow-out or collapse" (p. 415) is but one example. He uses such parallels with all the freedom that has become common in scientific papers nowadays. But one never gets the impression that he has sacrificed any of the dignity of the science.

References to later sections are frequent throughout the book. For this reason it can not be easy reading for the general public whose knowledge of astronomy is meager. It does not, however, diminish its merits as a text-book for class use, or as a reference book. These merits are considerable. The book easily deserves a prominent place among the several good text-books that have recently appeared.

DIRK BROUWER

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REPORTS

THE LÜBECK DISASTER[1]

OF the children inoculated in Lübeck with the BCG vaccine, more than fifty have died. Unfortunately, according to medical opinion, further deaths are to be expected, as the disease covers a period of from one to two months and the vaccinations were carried out at different times. The federal ministry of the interior has just published a statement based on the results of the inquiry as far as it has progressed. The statement throws a new light on the events in Lübeck and shows with what energy all persons in authority are working to clear up the matter. The statement of the federal ministry of the interior is expressed in precise terms and reads thus:

As was unfortunately to be expected, the terrible disaster that overtook the population of Lübeck in connection with the treatment to establish in children immunity to tuberculosis has not proved to be a catastrophe of only short duration but a calamity involving a series of fatalities and protracted illnesses the end of which is not yet definitely in sight. It is easily intelligible that the excitement over the sad event does not die down at once and that at home and abroad the demand for a more complete explanation of the disaster continues to persist. From the tone of the statements made by the federal minister of the interior, May 21, at the session of the head committee, and, June 16, at the plenary session of the reichstag, it was plainly evident that the investigations of the matter had been begun promptly and that they would be prosecuted without sparing any person or the prestige of any scientific method. Since, however, in some quarters suspicions to the contrary found expression, attention must be called to the fact that the scientific side of this affair involves some of the most difficult problems of bacteriology. The Federal Health Bureau was entrusted by the Federal Ministry of the Interior with the prosecution of the scientific investigations. The definitive outcome of the inquiry can not be announced before three to four weeks.

So far as it is possible to form an opinion from the investigations to date carried on by Professor Dr. Ludwig Lange, who was entrusted with this end of the research, it may be stated that the Calmette culture supplied by the Pasteur Institute in Paris was above reproach, but that it became contaminated during the process of recultivation in Lübeck. It is not open to question but that the Federal Health Bureau is using all available scientific means in the investigations that are being carried on to throw light on the complicated problem—investigations that are planned on a wide scale and will require the use of 600 or more experi-

[1] Berlin correspondent of the *Journal* of the American Medical Association.

mental animals. The frequently expressed wish that the course of the investigation might be expedited can not, however, be complied with, since biologic processes are involved in which any such attempts to influence matters are out of the question.

Separate from the question devolving on the Federal Health Bureau whether or not the Calmette prophylactic material as such was capable of producing the severe tuberculous infections in the infants instead of protecting them against the disease must be considered the question whether or not everything was done in Lübeck to carry out in a manner above reproach the Calmette prophylactic treatment, after it was once decided to employ it. The investigation of the manner in which the vaccine was employed is primarily the duty of the state of Lübeck. In the course of the investigations, a series of incriminatory charges developed, as was foreshadowed in the report of the referee sent to Lübeck by the Federal Ministry of the Interior, May 22. In this connection, the following points merit consideration.

1. After the federal ministry of the interior, in 1927, in the matter of protective treatment against tuberculosis by means of living bacilli, in agreement with the conclusions reached by the federal health council, had recommended a conservative policy, it would have been proper if the Lübeck centers concerned, before instituting the vaccine treatment, had inquired whether or not the federal ministry of the interior, in spite of many favorable reports from foreign countries, still preserved its waiting attitude.

2. After the original culture secured from the Pasteur Institute had been recultivated for nearly nine months in the Lübeck laboratory on various cultivating mediums, it would have been wiser, before the first application of the protective material to infants, to test its potency by animal experimentation. That was not done.

3. The surveillance of the children who were inoculated with the vaccine was not adequate.

4. The destruction by Professor Deycke, April 26 (that is, after the harmfulness of the protective material had become known), of the supply of vaccine left in his hands must be regarded as of questionable indication, irrespective of the motives that induced the act. Professor Deycke's action did not, however, militate against the clearing up of the affair, since the Federal Health Bureau was able to secure possession of entirely sufficient remnants of the protective material employed. The Federal Health Bureau was able to obtain all other research material needed.

5. It can not be justified that, after the forenoon of April 26, when the harmfulness of the protective vaccine employed had been proved by the necropsy on one of the infants who had died, several doses of the vaccine were allowed to remain in the hands of midwives. Fortunately, this remaining vaccine was not administered to any new subjects but only to such infants as, before April 26, had already received the first inoculation, which was probably decisive as regards the transmission of the infection.

6. It is subject to censure that the persons who were responsible for the application of the protective vaccine, among whom there seems, too, to have been a lack of cooperation, did not inform until a late date the center in Lübeck having first jurisdiction in such matters, of the damage that had been done. The *Reichsmedizinalverwaltung* (federal administration of medical matters) was not informed of the events until May 14.

To what extent the charges, or censures, mentioned (which do not essay to pass a judgment on the scientific merits of the Calmette procedure) should or may be considered in determining the matter of culpability, will be established by the criminal procedure, which has already been instituted.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

INTRA VITAM TECHNIQUE FOR THE STUDY OF THE LIVING CELLS OF INSECTS

THE method of studying living germ cells as practiced by Lewis and Robertson,[1] Strangeways and Canti,[2] Bělăr[3] and others shows certain lacks and deficiencies. These are evidenced by the appearance of pseudopodia, fused cells and nuclei and other abnormalities. Such irregularities do not appear in well-fixed material and we do not believe that they are a part of the behavior of germ cells in normal conditions of development.

We have been able to develop a technique for insect germ cells in which such abnormalities do not appear, due to the fact that the body pressure (follicular and cystic) and specific ferments are not disturbed. Neighboring cells are not separated from each other or from the surrounding tissues. Hence no fusion of spermatocytes or spermatids occurs, nor do

[1] M. R. Lewis and W. R. B. Robertson, (II) "The Mitochondria, etc., in Chorthippus," *Biol. Bull.*, 1916.

[2] T. S. T. Strangeways and R. G. Canti, "The Living Cells in Vitro as Shown by Dark Ground Illumination and the Changes Induced in Such Cells by Fixing Reagents," *Quart. Jour. Micr. Sci.*, 71, 1927.

[3] K. Bělăr, "Beiträge zur Kausalanalyse der Mitose. II. Untersuchungen an den Spermatocyten von *Chorthippus lineatus*," *Arch. Entw. Mech.*, 118, 1929.

pseudopodia ever appear, such as all workers, using the tissue culture methods, report.

We are calling this the intra vitam method in contradistinction to the earlier in vitro method. We feel confident that it has some merits over the older ones. Because it is simple and practical we are publishing the method before the longer paper, giving the details of our observations as well as the photomicrographs and drawings, is completed. It is so easy to use that we shall employ it in the future as a part of the laboratory work in cytology.

TECHNIQUE

A male grasshopper of suitable age is anesthetized for several seconds. As soon as the ether has taken effect, the hind legs are severed at the autonomous joint. The wings are cut off behind the pronotum, and a rectangular opening, about 2 mm by 1 mm, is cut through the chitinous wall of the second, third and fourth abdominal segments, just left of the mid-dorsal line. The insect is then placed on its right side, parallel to the width of a sterile glass slide, to which it is firmly attached by means of melted paraffin. The paraffin is drawn into a pipette and is then carefully dropped onto the forelegs and antennae of the grasshopper. The paraffin is run around the head of the insect and along the ventral side of the body, which faces the right-hand side of the glass slide. A narrow ribbon of paraffin is continued around the last abdominal segment and on out toward the left side of the slide for about 15 mm. Next, the paraffin is led up and back to the anterior end of the grasshopper (see figure). These three paraffin walls, ap-

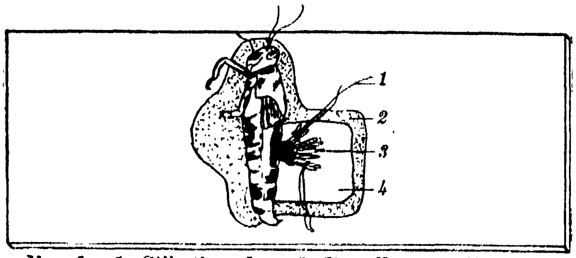

FIG. 1. 1. Silk threads. 2. Paraffin. 3. Follicles. 4. Lake of medium.

proximately 15 mm by 10 mm, together with the body of the grasshopper and the enclosed surface of the medium (Bělăr, '29), convert this basin into a nutrient lake. A hot needle applied to the outer rim of the paraffin wall insures close adherence to the glass slide and prevents leaking.

Care must be taken, when affixing the grasshopper to the slide, that the spiracles in the abdominal wall are not flooded with paraffin. The anal aperture is also left free so that normal evacuation can take place in preparations which are to be maintained for several hours.

Before the grasshopper recovers from the effects of the anesthesia, the testes are drawn out through the aperture in the abdominal wall. The yellowish connective tissue membrane, which encloses the tightly packed follicles, is carefully torn away with a sharpened needle point and the follicles float out into the lake of medium. They remain attached, of course, at the proximal end, to the vasa efferentia. Several of the upper ones, as well as two or three of the lower follicles, are secured with a loop of silk thread. The loop is drawn tight and firmly fastened to the wall of paraffin with a drop of melted wax. This attachment of some of the free follicles prevents the withdrawal of the testes into the body cavity and it lessens the movement of the intervening follicles.

The eight or ten free follicles, exposed along nearly their entire length, may be studied for hours, at intervals or continuously. In time the culture medium evaporates slightly and must be renewed. It is best to draw off the used medium and fill the lake with fresh fluid.

OBSERVATIONS UNDER THE MICROSCOPE

Some of the interesting things that we have observed with the 16 mm objective are the tridimensional or tubular nature of the follicle; the shape of the cysts with their walls; the variations in the shape of the cysts. These increase greatly in size and the walls thicken as they grow. In the spermatid region the cysts elongate greatly, the conical structure reaching down toward the center and proximal end of the follicle. The stages of germ cell development can also be recognized and their place of occurrence in the follicles fixed. The bundle of sperms in the grasshopper as they move and turn (Landrum, work unpublished) can be followed. The turning of the sperm in the crickets (Baumgartner, work unpublished) can be recognized.

With a 1/12 water immersion objective and good illumination (a bright substage lamp) practically every structure previously described in fixed material may be studied without the aid of intravital staining.

The walls of the follicles are thick and most probably muscular. Cysts of spermatogonia are readily distinguished from spermatocytes by their locus, size and cellular inclusions. Spermatocytes go through the various stages of cell division while under observation. Spermatogonia also divide. Chromosomes can be watched as they migrate from the equatorial plate to the poles. Here a very small refractive spherical centrosome is visible. Astral rays may be seen radiating from this point or body. Numerous threads of mitochondria are distributed to the daugh-

ter cells and form the nebenkern. Telokinetic movements can be followed. The young spermatid cells have short axial filaments. These can be seen to elongate and become the tails of the more mature spermatids. The long tails can be traced from the heads down toward the open end of the follicle. The tails are in groups and are more or less intertwined. The aggregation of the sperm into bundles can be studied, as well as the movement of the bundle to the open end of the follicle.

Preparations of crickets and beetles have been set up, with slight modifications of the technique. It is best to mount a cricket with the back flat on the slide. The follicles are shorter and the cells are smaller, but they may be studied by using the above-described method.

We have been able in a few months to see most of the characteristic structures and to follow many of the activities of the *living* germ cell, in a state that very nearly approaches the normal condition. We anticipate that our continued efforts will bring out other important data. It may not be too optimistic a viewpoint to expect the solution of some knotty problems in chromosome behavior and spermatid transformation by the use of this method. With such a hope we are offering the details of the method to other investigators.

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M. Anthony Payne
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A RAPID POSITIVE CONTROL METHOD OF HANDLING SMALL QUANTITIES OF LIQUIDS

For a certain experiment here there was needed a means of adding small quantities of liquids that would make it possible to secure more positive and satisfactory control than is afforded by any ordinary pipette or burette. The final design of the special tube or pipette for this purpose is shown in Fig. 1. As is at once apparent, the pipette substitutes a mercury plunger or piston for the usual rubber bulb or the rubber tube connected with the mouth. By inclining the pipette at an angle such as indicated and rotating it until the mercury has filled bulb N the air on the N side is crowded out at the tip. If now the tube, still at the same angle, is inserted into the liquid supply and rotated about its own axis until the mercury runs from N into the bulb M the liquid will be drawn up into the pipette to a height depending on both the angle of inclination and the amount of rotation, each of these conditions being subject to definite control individually. Scratches on the tube corresponding to volumes desired for particular work make the tube suitable for quantitative work. To expel any quan-

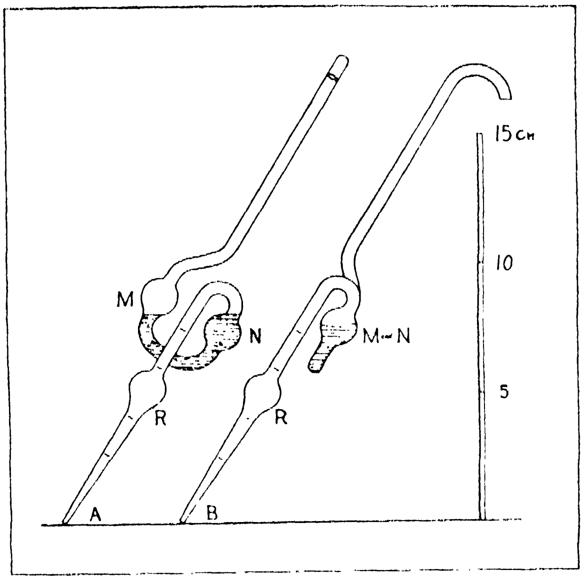

Fig. 1

tity of the liquid from one drop to the entire quantity contained one has but to rotate the pipette in the reverse direction, the mercury flowing back into N and crowding out the liquid to an extent positively controlled by either the inclination or the rotation, or both.

Compared to a burette in handling small quantities of liquids it is much more quickly filled and emptied and involves none of the uncertainties of either a stopcock or a pinch-cock. It is superior to any type of pipette operated by suction from the mouth, directly or through a short length of rubber tubing, for it eliminates any chance of fumes or liquids being inadvertently drawn into the mouth, as well as all danger of mouth or breath moisture contaminating the pipette, and relieves the user of the rather unpleasant and often inconvenient, if not unsanitary, use of his mouth.

On many grounds it is to be preferred to a pipette using a rubber bulb, particularly where definite quantities are required. When using a rubber bulb one is never sure just how much it should be squeezed in order to get the precise quantity needed—if too little, one has to begin over; if too much, one has to remove it from the liquid before it is fully distended and then allow air to bubble through the liquid, spraying the same into the bulb, or else must maintain the pressure on the bulb just so until the liquid is ejected. Rubber bulbs become contaminated and the contamination is invisible. They are flabby, often leaky, and offer uncertain control of the position of the tip of the pipette, in contrast with the rigidity of the new type. In using ordinary pipettes the heat of the hand is likely in the case of volatile liquids to cause a vapor

pressure so high as to expel the liquid from the pipette prematurely. In the new pipette the heat of the hand can have no effect whatever as the upper end is open. It is obvious, also, that a pipette of the new type may be easily cleaned. It should be stated that the bend at the upper end, though neither necessary nor given originally, was later added to make it possible either to hang it up or lay it on the table without involving any contamination of either its tip or of the table, for the bent portion is just long enough to make the tip incline downward, but not long enough to cause it to touch the table.

Inasmuch as pipettes of this new type have already found a place in three departments here it is thought to be of sufficient general use to justify passing the idea on to others.

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SPECIAL ARTICLES

EXCESSIVE TAX ON SOIL FERTILITY BY CROP PRODUCTION ON POOR LAND

"UNTO him that hath shall be given—from him that hath not shall be taken away even that which he hath." The above verse of Scripture finds further verification in the larger amounts of certain essential nutrients exacted from the soil by some plants, among them such important cereals as wheat and barley, per unit weight of mature crop grown on poor land than if grown on rich soil. That a soil markedly deficient in available phosphorus or nitrogen must supply more of these elements for the production of a unit weight of wheat or barley grain than is required from a soil fairly rich but not oversupplied with these elements lies in the relationship which the supply and absorption of given quantities of essential elements at various growth periods of the plant have to yield.

It appears from the standpoint of plant nutrition that the conditions which determine crop production can be reduced to three general considerations or factors. They are: (1) the minimum requirement (quantity) of each essential element needed to produce a unit quantity (weight) of mature plant and of its differentiated products, for example, in cereals —grain, straw and roots; (2) the time required for the soil (or other growth medium) to supply given amounts of each essential element and for it to be absorbed by the plant at given growth stages; (3) the length of time required for a given quantity of each essential element after it is absorbed to function to completion in the processes for which it is required and to attain the minimum percentage in the mature plant product of which it becomes a part.

The values of each of these three factors are different with the elements concerned. For example, the amount of phosphorus required to produce a given quantity of wheat grain is different (smaller) than that of nitrogen. The time required for a soil to provide a given unit quantity of available phosphorus to wheat plants is much longer (except in rare cases) than that required for nitrogen. The time required for a unit quantity of phosphorus, after it is absorbed by the wheat plants, to function to completion, that is, for the plant to increase in weight until the quantity becomes the limiting factor to growth, is much longer than that for nitrogen. The values of each of the above three factors are different among plant species; they also vary among varieties of any given species.

The time required for a poor soil to supply plants, for instance, wheat, with a given quantity of a given plant food—phosphorus, for instance—is different (longer) than it is in the case of a soil that is fertile as to this element. This difference projects the time when equal quantities are absorbed by plants grown on such different soils much later in the growth development of the plants grown on the poor soil than in the case of those grown on a rich soil. But as the total growth period of many plants is largely fixed by their genetic constitution—although the actual growth period varies more or less with soils and climatic conditions—it follows that the developmental stage obtained when equal quantities of an element are absorbed by plants grown on such different soils would be much nearer to the period of maturation for those grown on poor soils than those grown on the rich soils. As a specified yield requires a quantity of each essential element, which can not be less than that indicated by the product of the weight of the mature plant times the minimum percentage of such element in the product, it follows that the time required for a plant to absorb that quantity when grown on a poor soil would much more restrict the time remaining for utilization of that material than would be the case if the plant was grown on a rich soil.

The maximum utilization, or growth, or increase in weight—whatever term is desired to express the phenomenon of the additions to the weight of a plant by the absorption of elements subsequently to the time a specified quantity of a given element was contained in the plant—is obtained when the given specified quantity enters the rôle of a limiting factor. The element attains its minimum percentage when the maximum amount of other elements have been combined with it,

or have otherwise been incorporated into the plant. As a time interval was required for the given quantity to be absorbed, so a time interval will be required for other elements to combine with it or become a part of the plant. But the quantity of other elements that will be added to the weight of the growing plant subsequent to the time the specific quantity of the given element is absorbed is conditioned by similar factors as those which affected the intake of the specified quantity in question—namely, the character of the soil and the climate together with that of the time available for the processes to proceed.

The genetic constitution of the organism brings on the termination of growth in due time regardless of how favorable other conditions may be. If one plant process is contingent on another and both stand together reciprocally in their relation to the whole organism, variation in one must have a corresponding reaction in the other. It is the contingent and in a measure reciprocal relation of the two processes—(*a*) the time required for a plant to absorb a given quantity of an element, (*b*) the time required wholly to utilize the quantity absorbed—that sets the condition whereby a soil deficient in an essential element like phosphorus is required to supply a larger amount of this element per unit weight of mature plant than is required from a soil well supplied with this element. That is, the longer the time required for the plant to absorb a given quantity, the shorter the time remaining for it to utilize it. If the quantity absorbed is too large or the time required to absorb any given quantity is too long in relation to the time required for complete utilization, the result of such a condition is that a higher percentage of the element will be found in various parts of the mature plant. The yield (weight) of plant that was obtained would also have been obtained by a smaller quantity of the element if absorbed at an earlier growth stage.

The relation of yield to the composition of a crop such as wheat or barley grown on poor soil as compared to that grown on a fertile soil has similarity to the relation between yield and composition expressed in the "Mitscherlich law" but obtained under diametrically different conditions. The relation cited in the latter case ("Mitscherlich law") of decreasing increments of yield with increasing increments of factor (the element deficient in the poor soil) supplied and absorbed by the plant is due to the fact that the time required for such increasing amounts to be absorbed projects the period when this is attained correspondingly closer to the period of maturation, and the time thus remaining for growth after the quantity is absorbed is too short to permit of its complete utilization—hence the high percentage of the element in various parts of the plant. The relatively high percentage of the element in the crop grown on a poor soil is due to the fact that the soil could not supply sufficient amount of the element in the early growth stage of the plant to effect the requisite vegetative development required for a large crop, and the largest part of the quantity which the plant did contain at the end of growth was absorbed too late to be effective. Cause for the relatively high percentage of phosphorus or nitrogen that is frequently found in wheat or barley grown under the conditions mentioned—a soil poor in one of these elements as compared with the soil fertilized with one of the elements—is thus due to the same factor: insufficient time for utilization after the given quantity is absorbed.

The relations above stated, however, do not hold for plants that are markedly less differentiated than are wheat and barley as to the requirements of the final products—grain, straw, roots.

A more complete account of the experiments will appear elsewhere.

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COMPARATIVE RACIAL DIFFERENCES IN COLOR-BLINDNESS[1]

CONGENITAL color-blindness occurs in three chief forms: the common form in which there is confusion between red and green; a rare form known as total color-blindness in which all colors are confused, and a very rare type in which blue is confused with yellow. Red-green blindness appears to be a sex-linked Mendelian character and occurs much more frequently in males than in females.

Interest in possible racial differences in congenital forms of color-blindness was first aroused by Gladstone in 1858, and much scattered work on the subject has been done since that time. Holmgren's wool test has been used most extensively, but this test as well as all those dependent on matching pigment hues is unsatisfactory. Recent work has shown that the wools probably detect only about half of the cases of true color-blindness. Of late years, tests have been made using figures on pseudo-isochromatic cards. Most of these tests consist of a series of plates on which a colored number is presented against a colored background, the diagnosis being made by the manner in which the subject reads the numbers. The best-known tests of this type are those of Stilling and Ishihara. Von Planta[2] compared results obtained by

[1] More complete details of this work together with a summary and comparison of studies by earlier investigators will appear in an early article.

[2] P. von Planta, "Die Häufigkeit der angeborenen Farbensinnstörungen bei Knaben und Mädchen und ihre Feststellung durch die üblichen klinischen Proben," *Graefe's Archiv für Ophthalmologie*, 120: 253–281, 1928.

several of these tests with those given by the anomaloscope and concluded that the series devised by Ishihara was the most satisfactory.

I recently used this test to investigate the incidence of color-blindness among American Indians of the Southwest as well as in a group of Negroes in New Haven. The results obtained are set forth below in comparison with those published on Europeans by von Planta[2] in Germany, and on white Americans by Miles[3] at Stanford University and Haupt[4] at Baltimore. The figures in the table are based on the Ishihara test and refer only to males.

COMPARATIVE TABLE

Race	Investigator	Number tested	Frequency of color-blindness	Percentage
White (Europeans and Americans)	von Planta	2,000	159	7.95
	Miles	1,286	106	8.2
	Haupt	448	35	7.8
American Indians	Clements	624	12	1.9
American Negroes	Clements	325	12	3.7

The percentages of color-blindness among the three widely separated groups of white males closely approximate each other. Taking the three groups together, the actual percentage of the defect among the 3,734 individuals tested amounts to 8.04 per cent. One case in Miles's group was totally color-blind, but all the rest were red-green blind.

Of the 624 Indian males tested, 392 were full bloods, among whom were found eight cases or 2.0 per cent. of red-green blindness. Of these eight cases, six qualified as completely green-blind according to the test while the other two were red-blind. Among the 232 mixed bloods, three cases or 1.2 per cent. of red-green blindness occurred. Two of these were completely green-blind and one was red-blind. In addition, one case of total color-blindness was discovered in the mixed blood group. This case exhibited concomitant symptoms of poor central vision, marked photophobia and nystagmus. A group of 202 Indian females was also tested, but no case of color-blindness was found.

Of the 323 Negro males tested, 205 were probably full bloods. Seven cases or 3.4 per cent. of red-green blindness appeared. Five of these cases were complete green-blinds and the other two were red-blind. Among the 118 obviously mixed blood Negroes were five cases or 4.2 per cent. of red-green blindness, four cases being green-blind and one red-blind.

Miles states that the proportion of green-blindness to red-blindness in the group he tested was approximately 3 to 1. This ratio holds for the group of von Planta where the percentage of green-blindness was 5.75 and that of red-blindness 2.2. In my own results, 2.7 per cent. of the Negroes were green-blind and 0.92 per cent. were red-blind. In the total group of Indians, 1.2 per cent. were green-blind while 0.48 showed red-blindness. Apparently the approximate proportion of 3 to 1 for these two types of color-blindness holds for each of the three racial groups.

The above results seem to indicate that racial differences in color-blindness do exist. In the case of the white groups, the nature of the sampling and the large number of individuals indicates that the incidence of the defect for white males may be rather confidently set at about 8 per cent. The Indian testees were drawn from several different tribes and probably constitute a fairly representative sample. While tests on a larger group might give an incidence somewhat different from that stated here, there can be little doubt that the frequency of color-blindness among Indians is much less than among Caucasians. The Negro sample is too small to do more than indicate the probability that the incidence of color-blindness among Negroes falls somewhere between that for Caucasians and Indians.

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[3] W. Miles, "One Hundred Cases of Color-blindness Detected with the Ishihara Test," *Journal of General Psychology*, 2: 535–543, 1929.

[4] Quoted by Miles, *op. cit.*, p. 538.

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SCIENCE AND HISTORY: A SHORT CONTRIBUTION TO PHILOSOPHY[1]

By E. C. ANDREWS

GOVERNMENT GEOLOGIST OF NEW SOUTH WALES

IF the ordinary member of the Australian and New Zealand Association for the Advancement of Science were questioned concerning the main objects of the association, he or she would naturally reply that the title is self-explanatory, implying, on the one hand, coordination and correlation of scientific work by cooperation, and, on the other hand, the promotion of harmonious social relations both between scientific workers themselves and between them and the general public. The question thus naturally arises as to the scope of the association's activities and the best means of securing the desired cooperation. A glance at the names of the sections reveals a range of subjects for discussion varying from mathematics, physics, chemistry, geology and biology, to economics, medical science, social science, education, psychology and philosophy. Whether we consider philosophy in its general meaning as inclusive of psychology, epistemology, ontology, logic, esthetics and ethics, or in its narrower sense as synonymous with metaphysics, it is evident that the subjects considered are so diverse as to imply the possession either of decided versatility or of a broad grasp of scientific method on the part of one who would attempt the correlation of these subjects. Coherence of parts (sections), at least, is necessary, however, and in view of the present centrifugal movement towards specialization with its resultant divergency of interests and tendency to misunderstanding between the workers in the peripheral excrescences

[1] Abstract of the address of the president of the Australian and New Zealand Association for the Advancement of Science, Brisbane, 1930.

thus formed, it appears advisable to direct one's attention centripetally, as it were, and investigate the possibility of the existence of a principle common to, or underlying, all.

One of the main difficulties encountered in seeking to promote cooperation among the students of scientific method in the various branches of knowledge (disciplines), especially in connection with the study of possible underlying principles, is the tendency in the individual groups to undervalue the work done in branches far removed. The physicist and chemist in their syntheses do not appear to value sufficiently the vast gulf separating complex material mixtures from vital sense, or coenesthesis, and intellection in organisms. The idealist, on the other hand, does not appear to note that "bodies have not been successfully separated except into bodies, as real matter," and so on; the materialist does not appear to take sufficiently into account the fact that "bodies evolving account neither for themselves, their nature and their fundamental order of resemblance and difference, nor for the nature and origin of consciousness, nor even as yet for their becoming good for conscious beings." Moreover, the psychologist, the physiologist, the physicist, the biologist, claim too great a scope individually in the exploration of various activities, which, although consentaneous in action, nevertheless may only be described as psychoneural parallelisms. The true philosopher was he who was styled συνοπτικός by Plato, that is, he who takes a "synoptic" or comprehensive view of the universe as a whole.

Gilbert, the philosopher-geologist of America, advocated the extensive use of the "intellectual excursion" among workers, the peeping over the shoulders of one's colleagues, as it were, in all departments alike, to learn the lessons of tolerance, sympathy and the probable interrelatedness of all at base. Darwin's utilization in the "Origin" of the results of Mathews' work on "Naval Timber" is an example of the value of the "intellectual excursion." Especially valuable is this method in teaching the subjective nature of our knowledge, and the dependence on empiricism for the most definite advance in all branches, and in revealing the strangle-hold which traditions and beliefs acquired in infancy, childhood and youth have upon workers in all departments alike.

In order to obtain a clearer idea as to the advance which the universe, or at least the organic world, may be expected to make in the distant future, an ideal Observer is assumed, who visits the earth on several occasions—(1) in early Pre-Cambrian time, (2) during the whole of historical time and (3) say about one hundred or one thousand millions of years hence. He is possessed of human emotions and general sympathies; his vitality is perennial, yet his strength and endurance are only those of human beings; he journeys to the earth in a special self-contained chariot, but because of his physical limitations he can not approach the stellar bodies within very many millions of miles; he has no "early" training, as understood by human beings, but springs full-fledged intellectually, thereby being without either the help or the incubus of early traditions, beliefs and revelations, and without desires resulting from the "stable animal heritages" which had been grafted onto the evolving organisms one by one from the Pre-Cambrian. On the other hand, he has access to the whole of human knowledge, in mundane and sacred literature alike, wherewith to form a judgment by his sympathetic but disciplined mind.

His visit during the Pre-Cambrian leads him to consider the universe as a great inorganic cosmos, being a similar but more complete presentation of the beautiful and simple picture set out by Jeans in "The Universe around Us." The real meaning of such a cosmos, however, he is unable to divine, inasmuch as there is vouchsafed to him no sign of mentality such as his own, except in the suggestion presented of a grand industry, firmly established and running well apparently on its own.

His second visit extends throughout the historical period. At the outset he is impressed with the different aspect the earth has assumed. Where before were only the signs of inorganic activities, he now sees the organic world as it is to-day; nevertheless he is still ignorant of the results of geology, biology, psychology and history.

At the commencement he is inclined to agree with the ancient philosophers, namely, that there are four or five elements—air, water, earth, fire, ether—and that there are three forms of substance or fact, namely, matter, intelligence and an underlying and pervasive activity giving rise both to material and so-called immaterial manifestations.

As he dwells with men and follows the history of races through their successive stages of barbarism, fetichism, inquiry, reason and intellectual decrepitude, he notes that there is a general advance intellectually and ethically, in undulatory fashion, the scepter passing from one race to another as reason in each in turn abdicates its throne, to pass into a trough of hedonism and skepticism.

Geology and biology now come to his aid and reveal to him a similar progress in the organic world from insignificant beginnings in Pre-Cambrian time to the highest organic structures and mentality, nevertheless in undulatory fashion, with the scepter passing from one animal and plant race or group to another better fitted to carry aloft the torch of progress. In all,

however, the advance appears to be of the nature of an imposed gift.

Several other points impress him, namely, the tendency in man to specialization in scientific study; the tendency in each department of scientific research to reveal an underlying unity of activity, or a close interrelatedness of the objects of special study, nevertheless indicating, in each case, a still deeper underlying unity as yet undiscovered specifically and perceived only "as in a glass darkly"; the peculiar separate rather than disparate powers of the objective and subjective (subliminal) mental activities in organisms; also the violent and determined opposition manifested generally to progress by organisms, the general opposition exhibited consciously to progress by man himself (considered as a whole) being well expressed in the epigrammatic line of Plautus, "Homo homini lupus." With all, however, he observes that this persistent opposition has never been able to block progress, although it has retarded it for short periods. History indicates also to the Observer that true advance comes only through cooperation, and that the latter stage can come only when man throws off "the clog of individuality and remembers that he has grand race connections."

The explanation of man's individualistic attitude is simple. The inorganic cosmos arrived first among the universal manifestations of an earlier activity. Thus, atomic, molecular, crystal and stellar worlds were developed before organic life. Gravitation, light, heat, electricity, magnetism, inertia, sound, and so on, are universal. The play of these inorganic activities was inexorable, and the earlier organic adjustments were directed in accordance with them. The organism had to meet the storm, the flood, the drought. Benevolence, sympathy and justice were unknown to them as such. The early organisms were to be rendered stable in this inorganic setting. On these stable organic heritages the subjective and objective mental activities developed with excessive slowness throughout geological time. Each stage in this parallel mental series developed in opposition, as it were, to the rigors of their physical environment. There were opportunities for consentaneousness of activity with these lower stable heritages, however, on the part of the higher qualities which became engrafted, or harnessed in parallel, one by one, and such harmony of adjustment or correspondence was accomplished sooner or later, but all unconsciously, on the part of the organism. An analogy may be seen in the difficulty experienced, so to speak, by an electron attaching itself to a rounded-out stable system, such as a noble (inert) gas, like helium or argon.

The comprehension of the universe is to come by inductive study, or, to revive a somewhat obsolete term, by perduction, implying an inductive-deductive process. Science advances in proportion to the capacity to develop organizing ideas whereby observations and experiments are "colligated into intelligible system." In scientific inquiry we endeavor to ascertain the plan upon which our material has been built. Facts are collected and experiments are conducted. After the plan is assumed to have been ascertained, the deductive method is employed to discover additional detail. It is generally recognized that an initial "flash of genius" is needed—the faculty of suggesting new and valuable hypotheses. No one at present knows why the flash of genius comes; it is possible, however, to indicate how to secure it. The mind must rigorously examine and check its data; an attitude of open-mindedness and freedom from "conservatism" must be observed, with a confident belief that the proper inference will come later after a period, as it were, of fallowness in "consciousness." In this inductive-deductive process, the objective mentality is the great inductive agent, the subjective apparently the deductive, the former giving scope for the abundant exercise of "free-will," the subjective opposing the way, so to speak, by its tremendous wealth of traditions, inherited beliefs and instincts, yet under proper discipline revealing a truly marvelous power of advance by the syllogistic method, once the correct premises have been presented to it with sufficient force.

All inductive study indicates an increasing appreciation of an underlying unity of phenomena, and "noümena," the disparateness of to-day being merely the separate, but related, of to-morrow. Physicists have broken down the partitions formerly supposed to separate mechanics, molecular physics, light, sound, heat, electricity. But a more subtle unity appears to underlie the proton, the electron and the energy. The biologist, the physiologist and the psychologist perceive the gradual development of complex syntheses from a primitive simplicity; the paleontologist tells us of the wonders of the factor of time in the development of each of the above syntheses, and his studies strongly indicate an underlying unity to the psychoneural (not psychophysical) parallelism exhibited in all organisms. Ethics, esthetics, art and calisthenics add their convergent testimony of correspondence and parallelism to biology, physiology and psychology. The physicist and the chemist perceive that as these higher correspondences or consentaneous activities are stripped off, one by one, the matter remains, that is, the material of the instrument upon which the tune of progress was played. Philosophy, in its broader acceptation, makes the "intellectual excursion" in order to bridge the gulf or gulfs separating the methodological parallelisms in organic activities. Phi-

losophy considers that these activities studied by science all belong to the universe; they all appear to be universal in their application under the proper conditions; in each department of research, moreover, an underlying unity is discovered; each succeeding generation of mankind discovers additional evidence of the interdependence and interrelatedness of all; it is, therefore, perhaps permissible to infer that all are the manifestations of a still deeper underlying unity, more far-reaching even than Einstein's law concerning the convertibility of matter into energy; moreover, since no energy can rise above its source, the universe, as the origin of all these activities, even of the "highest qualities" such as intellection and altruism, may be inferred to comprehend, sympathize with and to appreciate to the full their origin, their gradual synthesis and their peculiar resultant attributes. In this connection it appears probable that inductive study will reveal noümena as the totality of phenomena. Nevertheless, the study of nature, as generally understood, will, by itself, be insufficient. The inner meaning of the "cosmos" can not be expected to come from any inference or hypothesis which excludes from its premises "the intelligence in which nature, as it were, gathers herself up."

The Observer perceives that universal progress has been unbroken and unfailing, and that man, or some similar organism, will penetrate to the inner meaning of "things." Merriam considers a related point in an interesting article in a recent number of *Scribner's* (1927) entitled "Are the Days of Creation Ended?" The conditions for man to occupy the dominant position appear to be that he shall think and act impersonally; that he shall employ the inductive method in the broader sense as mentioned above; that he preserve his "stable heritages" intact, and that he appreciate time in generous terms as an essential factor in universal progress. The knowledge that was Newton's and Darwin's is to be but a basement stone, as it were, to the mighty temple of knowledge whose peak is to pierce the clouds. The greatest intellect, or the mind of the seer, is but a base upon which greater and grander examples are to rise and rest in countless thousands.

SOME SCIENTIFIC INSTRUMENT MAKERS OF THE EIGHTEENTH CENTURY[1]

By ROBERT S. WHIPPLE

ALTHOUGH numerous references are found in early British manuscripts to instruments of an elementary kind, chiefly for the determination of time or position, there is little evidence that before the sixteenth century scientific instrument making as a craft had obtained a position of any importance in Great Britain. The demand for instruments to assist navigation became more insistent as new lands were discovered and the length of the voyages increased.

Gradually the professional scientific instrument maker came into existence, two of the more distinguished being Humphrey Cole, the maker of the astrolabe used by Sir Francis Drake, and Elias Allen, the maker of Oughtred's double horizontal dial. In a book by Oughtred, dated 1632, describing the double horizontal dial, it is stated that it is printed for Elias Allen, "Maker of these and all other Mathematical Instruments, and are to be sold at his Shop over against St. Clements Church without Temple-barr."

With the discovery of the telescope in 1608 and its development by Galileo in the following years a great impetus was given to the instrument-making industry. Although Gregory and Newton propounded the reflecting telescopes known by their names in 1663 and 1666, they were unable to find makers capable of developing their ideas. Newton made his own instruments, but it was not until about 1730 that John Short, of Edinburgh, succeeded in making a Gregorian telescope.

The latter half of the seventeenth century was a great period of scientific development. Experimental science, under its leaders Boyle, Hooke, Newton and others, created a demand for scientific instruments which could only be satisfied by skilled craftsmen. The work of Hooke and Leeuwenhoek did much to develop the microscope and to draw attention to the possibilities of the instrument. Fortunately an instrument made about 1670, and somewhat similar in its details to that described and illustrated in Hooke's "Micrographia" (1655), has been preserved, and by Mr. Court's courtesy is exhibited here this evening. The evidence is, I think, convincing that this instrument was made by Christopher Cocks, the well-known telescope maker, who lived in Long Acre, and of whose telescopes there are at least three in existence. It is known that in March, 1672, Cocks was ordered to make a four- or five-foot Newtonian reflecting telescope, but the instrument was not successful. About 1680 he was admitted a freeman of the Spectacle Makers' Company.

[1] Address given at the weekly evening meeting of the Royal Institution of Great Britain, Friday, May 23, 1930. Lord Rayleigh, Sc.D., F.R.S., manager and vice-president, in the chair.

Owing to the publication of the "Micrographia" with its description of Hooke's microscope, great interest was created in microscopical work, and a demand arose for microscopes. Owing to the high quality of the optical and mechanical work the English microscope won a high reputation.

The greatest of the English instrument makers who bridge the seventeenth and eighteenth centuries is undoubtedly John Marshall. Nothing is known of his early life, but part of a diary recently discovered in the British Museum by Mr. H. W. Robinson, by whose courtesy I am able to publish an extract, has thrown an interesting sidelight upon Marshall's career. The record covers five years of Hooke's life, 1688 to 1693, with the exception of some few months, and was thought to be the diary of James Petiver, an apothecary friend of Hooke. Mr. Robinson has been able to prove that it was written by Hooke. The following is an extract, December 14, 1688: "One John Marshall who told me he was Dunning apprentice & now worked at turning at the 3 keys in Ivy Lane came to shew me some microscopes of his own making he told me Mr. Boyle had bought such of him." He appears to have set up later at the sign of the Gun as a maker of spectacles and microscopes, and there is little doubt that the microscopes were of the Hooke type. By 1690 he had built up a large business and had introduced a new method of grinding lenses on brass tools. Marshall's double microscope was undoubtedly the greatest advance made in microscope construction for many years. The instrument was fitted with coarse and fine focusing adjustments, and for the first time the limb which carried the eyepiece, the object-glass and the object formed one complete system which could be inclined as one unit. All the features are retained in the modern instrument.

The first outstanding English instrument maker in the eighteenth century is undoubtedly Benjamin Martin, a man who, as far as is known, was not apprenticed to the trade. He was born at Worplesdon, Surrey, in 1704, and began life as a plowboy, later becoming a teacher of the "three Rs" at Guildford. He devoted his spare time to the study of mathematics. A legacy of £500 relieved him from the necessity of teaching and enabled him to travel and lecture. He appears to have assisted at the lectures given by Dr. J. T. Desaguliers, which were eagerly attended by the fashionable world and were illustrated by experiments. Horne, afterwards president of Magdalen College, Oxford, sarcastically remarked that Ben Martin "who having attended Dr. Desaguliers' fine raree gallantry show for some years in the capacity of a turnspit, has, it seems, taken it into his head to set up for a philosopher." This is a hit at Martin's literary efforts, because he proceeded to publish a large number of text-books dealing with a great range of subjects. When it is considered that Martin was a self-educated man, the extent and thoroughness of his knowledge as shown in his publications are remarkable. He appears to have lived some time at Chichester, where he kept a school, and also wrote several elementary text-books and pamphlets describing scientific instruments. There is little doubt that he commenced to make scientific instruments in Chichester, not improbably being asked by the readers of his books where it would be possible to obtain the instruments mentioned.

About 1750 he moved to London to a house in Fleet Street, three doors below Crane Court, where he became famous as a scientific instrument and spectacle maker at the sign of "Hadley's Quadrant and Visual Glasses." Martin was essentially a teacher, and continued to write after he had made his home in London. The books impress one with the care he takes to make every individual step in an explanation clear, and with the detailed drawings and references with which he explains the construction and use of an instrument. This is strikingly illustrated in his description of the various orreries he constructed. The orrery was almost the latest scientific novelty, and Martin appears to have been much impressed with the educational possibilities of the instrument. In his "Young Gentleman and Lady's Philosophy in a continued survey of the works of Nature and Art"—a book which had a great vogue—he uses planetaria to describe the difference between the Ptolemaic and Copernican systems, and the phenomena of eclipses, etc. He was evidently prepared to supply either form of planetarium to suit his customers' wishes. In one of his tracts published in 1771, "The Description and Use of an Orrery of a new Construction," he gives full details of the capabilities of the instrument, and also "the theory of calculation for the wheel-work of an orrery to the most extreme Degree of Accuracy." The prices of the instruments ranged from £12 12s. upwards, depending on the number of bodies demonstrated, and the accuracy of their movements, or as Martin himself states "proportional to the work." That Martin must have continued to lecture till late in life is shown by the fact that the apparatus made is adapted to show "all the Phænomena [*sic*] of the Transits of Mercury and Venus over the Face of the Sun such as I shewed in Public to Thousands on the late memorable instance of 1769."

In 1740 Martin published a useful text-book on optics, "A New and Compendious System of Optics," and in many other writings took immense trouble to explain optical systems and instruments. His microscopes and especially his cabinets containing two or three instruments of various types were much sought

after and still remain as examples of first-class workmanship and ingenuity. There is little doubt that he invented the drum type of microscope which had a great vogue, and is still made in large numbers on the Continent. If the invention of the glass micrometer as applied to a microscope was not actually due to him he was undoubtedly one of the first to employ it. He was also one of the first to apply rack and pinion focusing adjustments to the compound microscope, and to fit inclining movements to the pillar carrying the stage and mirror.

It is a cause of wonder to me how Martin was able to produce such a large number of books. The Dictionary of National Biography mentions thirty-one, although some of them are only leaflets. Many of his books passed through several editions, and at least one was translated into French. They undoubtedly helped to popularize science and to create an interest in scientific instruments. Shortly before his death at the age of seventy-seven he took his son into partnership, and unaware of the state of his affairs was adjudged bankrupt. He thereupon attempted suicide, and the wound hastened his death. His valuable collection of fossils and curiosities was sold by public auction for a trifling sum—a tragic ending to a more than usually successful career.

George Adams, the elder, perhaps the greatest of English scientific instrument makers, was born about 1704. It is known that he was apprenticed in 1718, and that he was established in business on his own account at Tycho Brahe's Head in Fleet Street in 1735. It is also known that he was making instruments for the East India Company in 1735–36. He obtained a world-wide reputation as a maker of globes. In 1766 he published the first edition of his book "A Treatise describing and explaining the construction and use of new celestial and terrestrial globes." Dr. Samuel Johnson, the lexicographer, wrote the dedication to the King, and for so doing received a present of "very curious meteorological instruments of a new and ingenuous construction." The book had a great vogue, passing through thirty editions.

Adams was essentially a mechanic, and delighted in good workmanship. There can be little doubt, I think, that the microscope was his favorite instrument, and he developed several types of it. In 1746 he published his "Micrographia Illustrata: or The Knowledge of the Microscope explained in several New Inventions, etc." The preface to the "Micrographia Illustrata" emphasizes the religious side of Adams's character, and also shows that he must have had the artistic and poetic temperament highly developed.

The first edition contained an account of a "New Universal Microscope," which was made to an entirely original design, the object being, as Adams states, "to have a Microscope which would be Portable and Universal, that is to say, ONE ONLY INSTRUMENT, by which all Sorts of minute Objects might be observ'd." The microscope was provided with six single lenses of different foci with a common focusing screw. Adams remarked of this focusing screw that it "is to be turned as your hands and arms are resting on the table, which is a conveniency to be met with in no other Microscope." A second edition of the "Micrographia Illustrata" appeared in 1747, and a fourth in 1771. Despite exhaustive researches it has not been possible to find a copy of the third edition—if it were ever published.

The fourth edition commences with a description of the variable microscope, of which Adams was evidently very proud. He states that "We owe the construction of the Variable Microscope to the ingenuity and generosity of a noble person," and we know that the "noble person" was the Earl of Bute. By having a compound eye lens and by introducing an auxiliary lens placed some distance above the objective the definition was improved. Adams also introduced the method of screwing two or three objective lenses one on top of the other. By drawing up the eye-piece relative to the object glass the power of the combination could be altered—hence the name "variable." Adams, in common with Martin and other makers of the period, developed the solar microscope with the large mirror projecting out of the window, by means of which brilliant illumination could be obtained and magnified images of the object projected on to a screen.

Adams appears to have given a great deal of consideration to the method of measuring the magnification of microscopes, and illustrates in detail in the "Micrographia Illustrata" (Plate 14, fourth edition) various micrometers for this purpose, amongst others the micrometer he made in 1761 for the silver microscope of George III. This instrument originally formed part of the King's Collection, and is now in the Lewis Evans Collection. It has been described by Messrs. Clay and Court at some length.[2] Although the details of workmanship in this instrument are excellent, the instrument as a whole must be regarded as an ornament rather than a serious contribution to microscopy. Such is not the case with the earlier instrument made for the King when Prince of Wales, and known as the "Prince of Wales" microscope. It is particularly interesting as embodying the method of mounting a microscope on trunnions—perhaps, as Clay and Court remark, the first microscope so sup-

[2] R. S. Clay and T. H. Court, "Two Microscopes made by G. Adams for King George III," *Journ. R. Micr. Soc.*, 1926, pp. 268–273, and *Supplementary Note, Journ. R. Micr. Soc.*, 1927, p. 255.

ported. There are three stages, one of which is of great interest, having micrometers registering in two directions at right angles. The screws have 100 threads to the inch, and the scales on the heads are divided into 100 parts, so that the micrometers read to 1-1000 in. A second stage was intended to carry a frog for demonstrations on the circulation of the blood. It is a matter of general knowledge that King George III was keenly interested in scientific matters and wished that his family should be instructed in science. Dr. Demainbray commenced to teach the royal family in 1754, and appears to have used for this purpose the apparatus which formed the major part of what is known as the King George III Collection. The instruments in the collection were catalogued in a manuscript book which is still preserved in the Kew Observatory and also in a catalogue which is now in the Science Museum at South Kensington. The instruments were housed at the Kew Observatory until 1841, when they were transferred to King's College, London. In 1925 they were removed to the Science Museum at South Kensington, where the majority of them can be studied. The story of the collection was told in some detail in a paper before the Optical Convention of 1926.[3] The majority of the instruments intended for instructional purposes were made by George Adams, although few of them bear his name. Fortunately two books of instructions have been preserved, and it is by means of these that it is possible to state that most of the instruments were made by Adams.[4]

The instructions consist of two manuscript books about 19 in. by 13 in., with two small books about 12 in. by 9 in. The pages of the latter are of blue paper, on which are pasted white sheets on which the illustrations have been drawn. One book is entitled: "A Description of an apparatus for explaining the Principles of Mechanicks made for His Majesty King George the Third by George Adams, Mathematical Instrument Maker to His Majesty. In Fleet Street, London, 1762." The second book is entitled: "A Description of the Pneumatic Apparatus made by George Adams in Fleet Street, London, 1761." In the case of the "Mechanicks" the final sheets of drawings were in course of preparation, the outlines having been drawn, but the shading is incomplete and reference figures have not been inserted. It was evidently intended that the sheets of drawings should be bound as a book to accompany the instructions, and probably that the latter should be bound also when the drawings were completed, but these were never finished. In the case of the "Pneumatics," drawings on plates the same size as the manuscript (19 in. by 13 in.) were in course of preparation, and those that are finished are excellently drawn. In the case of both books it was no doubt intended to have the manuscripts bound—as they are now a series of loose leaves in rough covers—but this was never done. The two books containing the comparatively rough drawings appear to have been the center around which Adams built up the experimental courses. In the case of the "Mechanicks" a little mathematical work is also included, although the course is essentially experimental and based on Desaguliers' translation of the classical work of 's Gravesande, the distinguished professor of mathematics of Leyden.[5]

Adams apparently cut out many of the illustrations from Desaguliers' book, and added pencil or ink modifications to guide the workman. An example of a modification of this kind is found in an apparatus intended to demonstrate experiments on pendulums and the impact of bodies; it is generally known as "'s Gravesande table." The central illustration in Plate 25 of Desaguliers' book has been cut out and modified. The additions are shown by the cross hatching, but the parts removed have been carefully cut away before mounting. The finished instrument can be seen at South Kensington, and comparing the original design with that made by Adams, one has to admit that the latter is more graceful than the original. The workmanship of the whole of this piece of apparatus is excellent. Adams evidently considered the cost of making apparatus, because several modifications are introduced with a view to reducing labor. The drawing of a table is shortened in pencil, with the words "Too long" written against it, and there are small pencil sketches at the side showing alterations. A ring is made to take the place of a fairly elaborate handle, and a simple glass basin is used instead of a brass bowl.

There can, I think, be little doubt that, judging from the large number of sketches that are dimensional, they must have formed the actual drawings from which the apparatus was built. Not improbably the workman had made some of the instruments previously for other customers, so that he did not require detailed drawings. The work of making the instruments may have spread over a few years. In the

[3] R. S. Whipple, "An Old Catalogue, and What it Tells us of the Scientific Instruments and Curios Collected by Queen Charlotte and King George III," *Proc. of the Optical Convention*, part II, 1926.

[4] It is by the courtesy of the Delegacy of King's College and the Director of the Science Museum that I have been able to examine these books.

[5] "Mathematical Elements of Natural Philosophy, confirmed by Experiments: or an introduction to Sir Isaac Newton's Philosophy." Written in Latin by the late W. James 's Gravesande, LL.D., professor of mathematics at Leyden, and F.R.S. Translated into English by the late J. T. Desaguliers, LL.D., F.R.S., and published by his son, J. T. Desaguliers. Sixth edition, 1747.

case of one of the pneumatic instruments mention is made of apparatus previously supplied and now "in one of the cabinets of the Palace at Richmond."

All through both books references are made to various scientific authors; for example, when discussing the Archimedean screw five references are given.

One of the most interesting instruments shown in detail is the rotating speculum suggested by Searson as an artificial horizon. Full details of the construction are given, and a manuscript copy of Emmerson's paper in the *Philosophical Transactions*, 47: 352, is included with the manuscript papers of the collection. Adams commences the description of the instrument with a short introduction:

> I recieved this invention from the late Sir Jacob Ackworth, first Commissioner of his late Majesties Royal Navy; soon after the inventor Mr. Searson was unfortunately lost on board His Majesties Ship the *Victory*.

Adams' mechanical ability shows itself in his instructions as to lubrication:

> It is necessary to put a drop of sweet Oil into the concave Steel polished segment of a sphere, for if the speculum be whirled without Oil it does not spin much above ten or twelve minutes, with Oil it will spin generally 36 minutes.

Only two of the illustrations are actually signed by Adams, although there is little doubt that the various notes are in his writing. There is a short four-page manuscript slipped into one of the books, which is a sheet of instructions with regard to some details of an instrument. Adams presumably wrote his notes out in this manner, and they were afterwards transcribed in the elaborate copy-book writing of the instructions.

The fourth edition of the "Micrographia Illustrata" is dated 1771, and Adams died in 1773. He must have lived a full life as, judging by the large number of instruments that may be found bearing his name, and by the "Catalogue of Mathematical, Philosophical and Optical Instruments" published in the end of the "Micrographia Illustrata," he must have had a large and flourishing business.

He left it to a son—George (born in 1750)—who added greatly to the prestige of the firm. He was a cultured man, and a favorite at court. He wrote a large number of books, the majority of which passed through more than one edition. The most famous of his books was his "Essays on the Microscope," published in 1787. In the preface he states frankly that he had intended to confine himself to a republication of his father's work, the "Micrographia Illustrata," but that knowledge of the subject had increased so much since his father wrote, that he felt the book had to be rewritten. Discussing the natural history side of the subject he states that he has endeavored to correct some of the faults in arrangement, etc., "by arranging the subjects in systematic order, and by introducing the microscopic reader to the system of Linnaeus, as far as it relates to insects." Chapter I is an extremely interesting history of the microscope, as observed by one who lived close to many of the inventions. In it he mentions that he invented an improved form of the lucernal microscope in 1774. In Chapter III he mentions that "this microscope was originally thought of, and in fact executed by my father; I have, however, so improved and altered it, both in construction and form, as to render it altogether a different instrument." He also mentions that "the great demand I have had for them has fully repaid my pains and expenses [*sic*] in bringing it to its present state of perfection." The lucernal was a simple compact form of projection microscope which met with general approval as an instrument which could be conveniently demonstrated to a number of people at the same time.

A second and enlarged edition of the "Micrographia Illustrata" appeared in 1798, edited with great care by F. Kanmacher. This editor in a footnote dwells on the fact that Adams had not given full credit to Benjamin Martin for what he had done to develop the microscope. Adams's "Geometrical and Graphical Essays," first published in 1790, was an extremely useful text-book for surveyors, civilian and military. The lectures on "Natural and Experimental Philosophy," first published in 1794, in five volumes, very nearly cover the range of physics as then understood—or, in the words of the subtitle, "describing in a familiar and easy manner the principal phenomena of nature, and showing that they all cooperate in displaying the goodness, wisdom and power of God." One is much impressed with the immense amount of work involved in the preparation of these books, for they are all full of individuality. The lectures were evidently written under difficulties. In the preface the author mentions "During the composition of these Lectures I have had to attend to the grateful calls of daily business, and have struggled with much weakness and langour." He passed away on August 14, 1795. We learn from an editorial note to the second edition of the "Essays on the Microscope" that Adams at the time of his death was preparing a new edition and that he had other books in view. After his death his books and instruments were sold by auction, and the stock and copyright of his books were purchased by the brothers W. and S. Jones. William Jones was responsible for the editorial work and the republishing of several

editions of Adams's books. The firm also continued to make instruments to the Adams design for many years.

The manuscripts and plates of Adams the elder were inherited by his widow, who gave them to her younger son Dudley. He edited a thirtieth edition of the "Treatise on the Globes," published in 1810. It is said that he had intended to publish another edition of the "Micrographia Illustrata," but it is not improbable that the revised edition (1798) of his brother's "Essays on the Microscope" rendered this unnecessary. Dudley Adams appears to have continued in the instrument business, as Mr. Court possesses a statement written on the back of a shop print, about 1800, of the wholesale trade terms for telescopes. These were evidently of the short brass draw-tube type which Dudley Adams had developed. The note attached to the price list states that "the object glasses not being single but achromatic" shows that non-achromatic glasses were sometimes sold.

Time has only allowed me to dwell in detail on four instrument makers in this century so full of scientific development. Their names are not so well known to the general public as those of Doliond, Herschel and Ramsden. Nevertheless the men whose work I have briefly described did an immense amount to popularize science and to raise the standard of scientific instrument craftsmanship. How world-wide this reputation for good work became is best seen by the number of instruments of English eighteenth century workmanship treasured in the Continental museums.

SCIENTIFIC EVENTS

THE INTERNATIONAL VETERINARY CONGRESS

THE International Veterinary Congress, which met in London during the first week in August, passed resolutions covering most of the subjects discussed on the previous days.

Delegates decided to accept the invitation of the American Veterinary Medical Association to hold the next congress in the United States in 1934, probably at Boston. Cheers greeted the announcement that the Budapest Prize, a gold medal, richly wrought, which was instituted when the congress met in that city, had been awarded to Professor Hutyra and Professor Marek, of Budapest, for the best work on veterinary science since the last congress. This consisted of a revised edition of a volume on the "Pathology of the Internal Diseases of Domesticated Animals." Professor Hutyra, who responded on behalf of himself and his colleague, is president of the permanent committee of the congress, rector of the Royal Hungarian Veterinary High School, and a member of the Upper House, Budapest.

Resolutions were carried with acclamation thanking the British Government and many individuals for their hospitality to delegates, and to Sir John McFadyean, of Leatherhead, for presiding. It was decided to increase the personnel of the permanent commission from 25 to 40.

In a resolution on foot-and-mouth disease, the congress urged that every country should determine the type of virus present in each outbreak. The most efficient disinfecting agents were moist heat and sunlight, and the chemical agents potassium, sodium hydrate and formalin. The value of passive immunity, according to the resolution, had been established, and its use in practice under favorable circumstances should be encouraged. It was desirable that all possible efforts should be made to discover an efficient method of active immunization.

The wide-spread occurrence of infectious abortion of cattle in all civilized countries led the congress to suggest an international scientific investigation within the purview of the International Bureau for Animal Diseases in Paris. The congress recommended the creation of a special section for meat and milk in the next congress. It also emphasized the necessity of state regulation for the control of the health of domestic animals, and for the title of veterinary surgeon to be protected by a recognized diploma.

The next resolution expressed the view that sufficient knowledge of practicable methods was now available to eradicate rinderpest within a reasonable period of time in any country which would provide adequate facilities for their application, and the congress urged all governments to cooperate to this end.

Resolutions were also carried concerning the teaching of zootechnics; the need for establishing in every country an organization similar to the German for combating diseases of the new-born animals, and the urgency for drawing up rules for the control and standardization of veterinary biological products.

INTRODUCTION INTO THE UNITED STATES OF PLANTS RESISTANT TO DISEASE

A STATEMENT given out by the U. S. Department of Agriculture states that two explorers of the department, H. L. Westover and K. A. Ryerson, are in North Africa looking for wilt-resistant alfalfas and fruits adapted to the United States. They will later continue their exploration in Spain.

Mr. Westover, a forage crop specialist, is now making preliminary surveys in the principal alfalfa-

growing districts of Morocco, Algeria and Tunisia, in order to return to Spain for the first portion of his collection trip. He will return later to these countries to collect the seeds from the harvest which is not yet ready. He made a similar exploration in southwestern Asia, the heart of the alfalfa district, last year, and brought back many varieties of alfalfa now being tested by the department for wilt resistance.

Mr. Ryerson, head of the Office of Foreign Plant Introduction, is looking for varieties of peaches and other fruits that will be of value in this country. He seeks particularly to recover some American varieties of peaches that have disappeared from production in this country after having become established abroad. He originally planned to join Dr. Frederic T. Bioletti, professor of viticulture at the University of California, who has been conducting an exploration for grapes and apricots for the department and the university in North Africa.

Professor Bioletti's illness has caused some alteration of these plans, so that Mr. Ryerson will have to take charge of the completion of his work. The preliminary work in connection with apricots has been completed, and there remains only the harvest of the seeds and scions. The grape work has not reached so advanced a stage but it is well under way.

Four or five years ago bacterial wilt appeared in the heart of the alfalfa belt and threatened to exterminate this crop. The San Joaquin Valley of California has suffered heavy losses from wilt. Losses in Kansas in 1927–28 amounted to about 15 per cent. and for the last three years in Iowa and Missouri to about 25 per cent. In Minnesota, Nebraska and Missouri wilt has worked hand in hand with crown rot, combining to bring losses up to 50 per cent. of the crop. In Colorado it is the most destructive disease of alfalfa, one field suffering loss of 80 per cent. of the plants. Wherever prevalent, wilt has done its greatest damage in humid climates and on irrigated lands.

THE NATIONAL INSTITUTE OF HEALTH

THE National Institute of Health has issued the following statement:

By the act of Congress approved May 26, 1930, entitled "An act to establish and operate a national institute of health, to create a system of fellowships in said institute, and to authorize the government to accept donations for use in ascertaining the cause, prevention and cure of disease affecting human beings, and for other purposes," the Hygienic Laboratory will hereafter be known as the National Institute of Health of the United States Public Health Service. The author of this measure was Senator Joseph E. Ransdell, of Louisiana.

The general purposes of the act are to provide large facilities for investigations of diseases of man and matters pertaining to the public health, to encourage research and the training of individuals engaged therein, to enable the government to accept bequests in aid thereof, and to bring about cooperation with scientific institutions in the prosecution of research work.

Public health investigations by the Public Health Service were first authorized in 1901. Since then substantial progress has been made and many new facts have been discovered which have had an important bearing on the prevention and control of disease. The necessity for this work far outstripped the facilities for its conduct. Under the above-mentioned authority, these facilities may be greatly enlarged.

In its development the new institute will have the advantage of the traditions of the Hygienic Laboratory. In reality the Hygienic Laboratory becomes the National Institute of Health which, with enlarged facilities, will be devoted to investigations of the underlying problems not only of communicable diseases but of degenerative diseases and environmental conditions affecting health.

In aid of this work the Secretary of the Treasury may hereafter accept gifts to be held in trust and used for the purposes mentioned; the expenditures to be safeguarded in all respects as are other governmental funds. These gifts may also be used for the establishment of fellowships to encourage individual scientists.

Appointments and services under these fellowships will be governed by laws and regulations affecting the United States Public Health Service. Individual ability is the most valuable asset of a people of a country. The object is to encourage postgraduates of extraordinary ability and to aid them to follow permanently their scientific bent in the interests of humanity.

In order that those who make gifts may have a living part in the development of the institute, provision is made whereby donations of $500,000 or over will be acknowledged permanently by the establishment within the institute of suitable memorials.

The Secretary of the Treasury has recently accepted a gift of $100,000 offered by the Chemical Foundation, Inc., through its president, Francis P. Garvan, under the provisions of the act of May 26, 1930, which authorizes the government to accept donations and to create a system of fellowships, etc., in the National Institute of Health. The condition is made that the income from this fund be used for one or more fellowships in basic chemical research in matters pertaining to public health, the details of which are left to the Surgeon-General and his advisory committee. The act provides that conditional

gifts such as this may be accepted by the Secretary of the Treasury if recommended by the Surgeon-General and the National Advisory Health Council.

THE CINCINNATI MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE meeting of the American Chemical Society at Cincinnati will open on September 8, continuing for the following four days.

On Monday at 2 o'clock there will be a meeting of the council and at seven in the evening there will be a subscription dinner, reception and dance at the Hotel Gibson for members and their guests.

On Tuesday there will be two symposia: Group 1 meeting under the auspices of the divisions of industrial and engineering, organic and cellulose chemistry and Group 2 meeting under the auspices of the division of physical and inorganic chemistry. The subject of the former will be "Industrial Fermentation," the speakers and subjects being: E. I. Fulmer, "The Chemical Approach to Problems of Fermentation"; A. A. Backhaus, "Ethyl Alcohol"; J. F. Garrett, "Lactic Acid"; Chas. N. Frey, "The History and Development of the Modern Yeast Industry"; C. L. Gabriel and F. M. Crawford, "The Development of the Butyl Acetonic Fermentation Industry"; F. C. Blanck, "Fermentations in the Food Industries"; A. M. Buswell, "The Production of Fuel Gas by Anaerobic Fermentations"; O. E. May and H. T. Herrick, "Some Minor Industrial Fermentations."

The subject of the second symposium will be "Non-aqueous Solutions." Those who will take part are: Charles A. Kraus, who will speak on "Reduction in Non-Aqueous Solvents"; Arthur W. Davidson, "An Introduction to the Chemistry of Acetic Acid Solutions"; F. W. Bergstrom, "Bases of the Ammonia System"; George Scatchard, "Equilibrium in Non-Electrolyte Mixtures in Relation to the Densities and the Vapor Pressures of the Component"; J. A. Wilkinson, "Liquid Hydrogen Sulfide," and J. W. Williams, "The Behavior of Electrolytes in Methyl Alcohol Solutions."

There will be divisional meetings on Wednesday and Thursday mornings, followed by luncheons at the University of Cincinnati. The president's address by Professor William McPherson, "Chemistry and Education," will be given on Wednesday at 8:30 in the Emery Auditorium, following which there will be a musical program.

On the afternoon of Thursday an inspection trip will be made to the Cincinnati Water Works and drive around the city in automobiles, starting from the university immediately after luncheon.

Friday will be devoted to visits to industrial plants, details of which will be announced at the meeting.

SCIENTIFIC NOTES AND NEWS

MRS. ANNA BOTSFORD COMSTOCK, emeritus professor of nature study at Cornell University, distinguished also as a wood engraver, died at Ithaca on August 23, aged seventy-six years. Professor John Henry Comstock, emeritus professor of entomology, survives his wife, but has been seriously ill for several years.

DR. FLORIAN CAJORI, professor emeritus of the history of mathematics at the University of California, died at Berkeley on August 14. Professor Cajori was born in Switzerland in 1859 and received the bachelor's degree from the University of Wisconsin in 1883.

DR. H. H. TURNER, Savilian professor of astronomy at the University of Oxford, died on August 20, while attending the International Congress of Geodesy at Stockholm. Dr. Turner was sixty-nine years old. He had many friends among American astronomers and was delegate from the British Association for the Advancement of Science to the American Association at the last New York meeting.

WHEN Northwestern University at the recent commencement exercises conferred the degree of doctor of science upon Dr. Gotthelf Carl Huber, dean of the graduate school of the University of Michigan, the citation, read by Professor Leslie Brainerd Arey, was as follows: "Distinguished son of the University of Michigan whose filial loyalty has been expressed in a life of unbroken devoted service; respected and loved by students as friend, teacher, and dean; a wise counselor, entrusted by his colleagues with important responsibilities in determining academic policies; fruitful contributor to the fundamental understanding of all branches of microscopical anatomy, whose researches are models of patient, thorough and accurate observation and experiment; pioneer in the application of certain precise methods to the unraveling of difficult morphological secrets; a practical but scholarly scientist occupying a unique position among American anatomists."

DRAKE UNIVERSITY at its forty-ninth commencement conferred upon Dr. Philip Fox, director of the new Adler Planetarium, Chicago, the degree of doctor of laws.

THE honorary degree of master of arts was conferred on June 23 by the University of Michigan on Harlan I. Smith, of the National Museum of Canada.

DR. WILLIAM MCPHERSON, of the Ohio State University, president of the American Chemical Society, will be the guest of honor and principal speaker at a luncheon to be given on September 9, during the meeting of the society in Cincinnati, by the assistant editors and abstractors of *Chemical Abstracts*.

DR. VIKTOR GOLDSCHMIDT, professor of mineralogy at Heidelberg, celebrated the fiftieth anniversary of his doctorate on August 6.

DR. FRIEDRICH EMICH, professor of chemistry at the Technische Hochschule in Graz (Austria), known for his work in inorganic micro-chemistry and analysis, will celebrate his seventieth birthday on September 5.

DR. WERNER HEISENBERG, of the University of Leipzig, has been elected a member of the Saxon Academy of Sciences in the section of mathematical physics. Corresponding members elected include Dr. Johannes Walther, professor of geology and paleontology, and Dr. Edmund O. von Lippmann, professor of the history of chemistry, both of the University of Halle.

A RECENT Order in Council reported in *Nature* directs that the Lord President of the Council (Lord Parmoor), the Minister of Agriculture and Fisheries (Dr. Addison), the Home Secretary (Mr. Clynes), the Secretary of State for Scotland (Mr. W. Adamson) and the President of the Board of Education (Sir Charles Trevelyan) shall be a Committee of the Privy Council for the organization and development of agricultural research. It is also ordered that the Lord President of the council shall be the chairman, and the Minister of Agriculture and Fisheries vice-chairman of the committee.

SIR CHARLES MARTIN, director of the Lister Institute of Preventive Medicine, London, and Professor Arthur Harden retire under the age limit this year and will be succeeded on January 1 by Professor J. C. G. Ledingham and Dr. R. Robison. Sir Charles Martin will take charge of the division of animal nutrition of the Commonwealth Council for Scientific and Industrial Research.

DR. JOSEF HOPMANN, Bonn, has been appointed professor of astronomy in the University of Leipzig.

AT the Iowa Agricultural College and Station at Ames, according to *The Experiment Station Record*, following the resignation of Dr. J. E. Brindley, head of the department of economics, history and sociology since 1913, to allow more time for research in public finance and taxation, Dr. A. G. Black, professor of agricultural economics, has been designated chairman of the department of agricultural economics. Dr. I. E. Melhus, professor of botany, has succeeded Dr. L. H. Pammel as head of the department of botany, the latter remaining as chief botanist in the station. E. M. Mervine, professor of agricultural engineering, has resigned to become associated with the U. S. Department of Agriculture in the investigation and development of sugar beet machinery.

DR. ARCHIE H. ROBERTSON has been appointed director of the State Food Laboratory at Albany, New York. He has been bacteriologist at the Experiment Station at Geneva.

DR. RICHARD S. UHRBROCK has resigned from the faculty of Cornell University in order to accept a position in the division of industrial relations of the Procter and Gamble Company, Cincinnati.

DR. W. A. TAYLOR has resigned from the position of vice-president and chemical director of the La Motte Chemical Products Company, Baltimore.

DR. HOMER L. CUPPLES has been appointed chemist of the Whittier, California, Station of the Bureau of Chemistry and Soils and of the Bureau of Entomology, where he will conduct studies on the toxicity and physio-chemical properties of hydrocyanic acid gas.

DR. S. F. LIGHT, professor of zoology at the University of California, will spend the late summer and autumn in a study of the biology and distribution of the desert termites of southeastern California, with headquarters at Beaumont from August 15 to October 15 and at Palm Springs from that time until the end of December.

DR. ALEŠ HRDLIČKA returned to Washington on August 15 from an expedition to Alaska.

DR. WILLARD BERRY, of the department of geology of the Ohio State University, has returned from France where he attended the hundredth anniversary of the founding of the Geological Society of France. He represented the Geological Survey of Ohio and the Ohio State University.

WILLIAM F. PROUTY, professor of economic and structural geology in the University of North Carolina, has returned with a class of twenty-two students from an eight weeks' transcontinental study tour of the United States, embracing most of the national parks and a number of mining centers.

DR. A. S. EDDINGTON, Plumian professor of astronomy at the University of Cambridge, gave a lecture on "The Inner Construction of Atoms" on the second day of the International Congress of Astronomy, held at Budapest during the second week of August.

AN official American delegation has arrived at Dresden from Washington to study the International Hygiene Exhibition with a view to reporting on the ad-

vances which have been made in hygiene education. The delegation is composed of Dr. Charles Wardell Stiles, of the United States Public Health Service; Major George C. Dunham, of the Army Medical School, and Captain Charles S. Butler, commandant of the Naval Medical School.

GENERAL SMUTS, of South Africa, is leaving on a botanical tour through Rhodesia, the Belgian Congo and Tanganyika as far as Lake Tanganyika. He will be accompanied by a government representative, M. K. Hutchinson, botanist from the herbarium of the Royal Botanical Gardens at Kew, and by Dr. I. B. Pole-Evans, chief of the division of plant industry of the Union, as well as by his brother, J. A. Smuts. The party will collect specimens of flora and will be away for at least six weeks.

SIR CHARLES MARTIN, who has accepted an appointment for two years as chief of the Division of Animal Nutrition of the Australian Council for Scientific and Industrial Research, will sail for Australia late in December, breaking his journey at South Africa to visit the veterinary research station at Onderstepoort. In the meantime he is visiting research institutions in Britain and Germany.

PROFESSOR M. W. WEINBERG, of the Pasteur Institute of Paris, known for his work on anaerobes and gaseous gangrene, will make an official visit to the United States in October and November of this year. He will deliver a series of lectures on bacteriological problems at a number of universities, including the Johns Hopkins, Pennsylvania, Michigan, Chicago, Wisconsin, Iowa, St. Louis and Denver. He will also visit the West Coast and speak before several French societies on the life and work of Pasteur.

THE United States Civil Service Commission announces the following open competitive examinations: Principal civil engineer, $5,600 to $6,400 a year; senior civil engineer, $4,600 to $5,200; senior electrical engineer, $4,600 to $5,200; senior mechanical engineer, $4,600 to $5,200; civil engineer, $3,800 to $4,400, and mechanical engineer, $3,800 to $4,400; for Boulder Dam and the proposed all-American Canal of the Reclamation Service. Applications for these positions must be on file with the Civil Service Commission at Washington, D. C., not later than September 10, 1930. The examinations are to fill vacancies in the Bureau of Reclamation, Department of the Interior, and vacancies occurring in positions requiring similar qualifications, for duty in Washington, D. C., or in the field. Positions in connection with the Boulder Dam Project will be filled from these examinations; also in connection with designs and specifications for the proposed all-American Canal of the Reclamation Service. Competitors will not be required to report for examination at any place, but will be rated on their education, experience and fitness.

THE United States Civil Service Commission announces an open competitive examination for the position of biologist to fill a vacancy in the United States Public Health Service, for duty at Boston, Mass., at $4,200 a year, and vacancies occurring in positions requiring similar qualifications throughout the United States, at entrance salaries ranging from $3,800 to $4,400 a year. The examination is open to both men and women not over forty-five years unless entitled to preference because of military or naval service. The duties of the position are to carry on, under general supervision, advanced biological researches, either individually or in cooperation with others, on animal and human materials, with particular reference to the acceleration or inhibition of cellular growth and similar related researches of a fundamental nature. The Public Health Service is engaged upon such studies, the immediate object of which is to discover some new facts bearing upon the cause and treatment of tumors. Competitors will not be required to report for examination at any place, but will be rated on education, training, experience, fitness and publications.

THE Department of State Employment and Registration, State Employment Commission, Baltimore, announces a vacancy in the position of chief of the Bureau of Chemistry, State Department of Health, at an initial salary of $4,000. The closing date for receipt of applications is September 10, 1930. As a prerequisite for consideration, applicants must have graduated from a college or university of recognized standing with specialization in chemistry; a postgraduate course in chemistry desirable, as well as thorough knowledge of and extensive experience and technical skill in chemical analysis, research and administrative ability, judgment, tact.

Industrial and Engineering Chemistry calls attention to the Basic Science Research Laboratory as a unit of the Institute of Scientific Research of the University of Cincinnati. It brings together representatives of various sciences for a cooperative attack on fundamental problems in borderline fields of pure and, to a lesser extent, applied science. At present attention is largely devoted to the effects of various forms of radiant energy upon living organisms. The laboratory will be open from 3 to 6 on the afternoons of September 9, 10 and 11. Special exhibits will be arronged, and motion pictures will be shown continuously. Guests especially interested in the work of the laboratory are, however, invited to visit it at any time. The laboratory is on the top floor of Cunningham

Hall, University of Cincinnati. The exhibits will include equipment for infra-red spectroscopy for the generation of the "soft" X-rays, and apparatus for the study of the effects of electrons upon bacteria. They will be arranged to show the unique organization of the laboratory, to make clear its aims and review its achievements.

THE first step in the establishment of a forestry school at Duke University, Durham, North Carolina, has been taken in the election of Dr. C. F. Korstian as director of Duke Forest and professor of silviculture in Duke University. Dr. Korstian is at present senior silviculturist at the Appalachian Forest Experiment Station of the U. S. Forest Service, Asheville, North Carolina. Complete plans for the school will not be made until after plans for the forest have been developed and further study has been made of the need for additional forestry training in the South and the opportunities available at Duke for specialized forestry education. Tentative plans for next year provide for a survey, inventory and preliminary management plan. The forest consists of approximately 5,100 acres adjoining the campus. The forest lies in the lower Piedmont region and consists of second-growth shortleaf and loblolly pines, and hard-woods. Because of the representative nature of this tract and because of its size and location it is expected to serve well as a research and demonstration forest. A research program will be developed, taking advantage of opportunities to cooperate with other departments of the university and with other agencies in the region, such as forest schools, state departments and the Appalachian Forest Experiment Station of the U. S. Forest Service. Since the plans for the school are now only partially developed, no curriculum has been made up and it is not planned to give courses next year.

THE late Charles F. Ruggles, lumber merchant of Manistee, Michigan, has bequeathed nearly all his estate, said to amount to $50,000,000, for education and public relief in the State of Michigan.

THE New York Homeopathic Medical College and Flower Hospital will receive thirty-five of the two hundred shares of the Wendel-Swope estate. This great fortune, estimated at one hundred million dollars, or more, will mean that something over seventeen million dollars will come to this institution. This bequest becomes effective on the death of an only surviving sister, Ella Von E. Wendel, who is eighty years old. The will further provides for an immediate gift of two properties at numbers 1 and 3 Third Street, New York City. The Wendel family have been frequent contributors to this college and hospital for more than forty years. At one time Georgiana Wendel was a special student in the college.

DEMOLITION of the "temporary" old mining building at the Pennsylvania State College has been begun as the School of Mineral Industries moved into its new building. The new building is one of the eight the state will officially turn over to the college this October at the celebration of the seventy-fifth anniversary of the signing of the charter; it will be put into use with the opening of college in September. The frame building which is being torn down originally was a temporary home for mechanics arts. Thirty years ago it was moved to its present location and became headquarters for mineral industries as the mining building. Intended to tide over a short period until sufficient funds were available for a permanent structure, the old building continued to serve until this year, although it was long ago inadequate for its purpose.

THE Bureau of Entomology has moved its offices from the brick buildings in the grounds, soon to be razed, to the second floor of wing 3, in temporary building C on Seventh Street near B Street SW. The packers and stockyards division of the Bureau of Animal Industry and the division of cereal crops and diseases of the Bureau of Plant Industry also moved recently to building C, where they now occupy the second floor of wing 2.

Industrial and Engineering Chemistry reports that the Hercules Powder Company on July 30 laid the cornerstone for the main building of new experimental and research laboratories at Hercules, Delaware, which is 3 miles west of Wilmington near the Lancaster Pike. Heretofore the laboratories have been located at Kenvil, N. J., but now they will be much nearer the main office and will be provided with new facilities. It is estimated that the cost of the new construction will exceed $500,000. The site selected comprises more than 300 acres and the new station thus created will be larger and more modern than the present equipment.

MR. LANSBURY, British first commissioner of works, stated recently that the Royal Botanic Society's Gardens, Regent's Park, on the expiry of the crown lease in 1932, would become the property of the public, which would then have free access to them. Questions as to the future of the Botanic Gardens were asked in the House of Commons before the rising of Parliament for the recess. Replying to Lieutenant-Colonel Moore, Mr. Lansbury said it was the intention of the government that the ground should be devoted to some purpose for the benefit of the public, and later, in answer to Sir William Davison, he stated that he

knew of no proposal to clear away the ornamental water or to interfere with the general appearance of the gardens. Yesterday Mr. Lansbury said that the beauty of the gardens would not be destroyed when the lease expired. The gardens would be added to Regent's Park and the public would be able to enjoy them. He added that no doubt provision would be made for carrying on horticultural research work.

DISCUSSION

ARE PLANETS RARE?

IN the August 15 number of SCIENCE Professor Jermain G. Porter challenges a statement of mine that "a planet is a very rare occurrence."

Permit me to quote as authority for this statement Sir James Jeans, who in his "Astronomy and Cosmogony" (1928) follows Chamberlain and Moulton in ascribing the birth of the solar system to the near approach of another star, which is necessarily a rare event. After developing the theory in detail, he concludes (p. 401):

> . . . only about one star in 100,000 is at present surrounded by planets. Planetary systems must then be of the nature of ''freak-formations''; they do not appear in the normal evolutionary course of a normal star.

Also Professor A. S. Eddington, in his "The Nature of the Physical World" (1929), p. 177, says:

> The data are too vague to give any definite estimate of the odds against this occurrence, but I should judge that perhaps not one in a hundred millions of stars can have undergone this experience in the right stage and conditions to result in the formation of a system of planets.

To a humble physicist it would seem that Mr. Porter is hardly fair to his fellow astronomers when he says:

> That double stars have planetary systems may be doubtful, but there is absolutely no reason for the assumption that the formation of families of attendant worlds may not be the ordinary course of evolution for the single stars.

Rather than referring to a second-hand account of a press interview with me, in which obviously no arguments or authorities could be presented, would it not have been wiser for Professor Porter to present his case for frequent planets in the astronomical literature for the consideration of Messrs. Jeans and Eddington and others of like mind?

ARTHUR H. COMPTON

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CURIOSITIES OF SCIENTIFIC NAMES

UNDER the above title, Dr. Gifford in a recent number of SCIENCE adds certain instances of "errors in nomenclature," particularly in the coining of new names, and implies that care should be used in seeing that these are bestowed with due regard to classical usage. That this is an excellent principle no one will deny, yet a book full of "odd stories about scientific names" will some day make good reading. The birth of a new scientific name is, with Dr. Gifford, a "serious business," but with those who have much to do with this matter of names the solemnity of the occasion eventually loses somewhat of its glamour. It is, of course, well known that many names are merely anagrams that have no classical counterparts, for names, after all, are nothing more than handles by means of which particular objects are designated. So *Daption* for the Pintado petrel is merely an anagram of that word; *Teonoma* is another formed from *Neotoma,* to designate a genus of similar rats; *Delichon* from *Chelidon* is another instance. But the element of subtle humor comes in where a deliberate play upon words, often inobvious to the uninitiated, is made. It was perhaps a doubtful compliment when one zoologist named a new skunk in honor of a colleague, but when another named a bat *carissima* few might see that it was in honor of its discoverer, Mr. Darling. The term *Kogia,* for a genus of strange looking cetaceans, is said to have been coined by J. E. Gray because it was an odd "codger." In like manner the name *clavium* by Barbour and Allen for the Florida Key deer, to which Dr. Gifford refers, was a deliberate pun, for which the authors are entirely unrepentent, while the name *keyensis* that he suggests would be not only an amateurishly and awkwardly coined word, but would obviously refer equally to Key Island near Papua. There are many other names that hide a bit of humor and all of which, no doubt, are a manifestation of that same twist of human nature that prompted the builders of cathedrals in the middle ages to add to the sacred structure in out-of-the-way places the faces or figures of demons or evil spirits as a relief from the seriousness of their undertakings. The Lincoln Imp is a famous instance.

> So they whistled the Devil to make them sport,
> Who knew that sin is vain.

G. M. ALLEN
T. BARBOUR

PRIORITY IN FAMILY, ORDER AND HIGHER GROUP NAMES

THE International Rules of Zoological Nomenclature provide that a family name shall be formed by adding *idae* to the stem of the type genus, and that if the name of the type genus is changed, the family name shall also be changed. It does not specify how

it shall be changed, however, and there does not seem to be general agreement whether the next younger valid name based on another genus of the family and already in family form should be used, or whether the new name of the oldest or the type genus should be given a family suffix. It would seem desirable to introduce some uniformity of procedure. For example, if the generic name *A-us* 1850, the type genus of the family A-idae 1850, is found to be a synonym of *B-us* 1840, should A-idae be replaced by a newly coined family name, B-idae, in preference to an already proposed name, C-idae 1860, founded on *C-us* 1860, if *C-us* is clearly a member of the same family as *A-us*? And if B-idae should be used in this case, if *A-us* 1850 must be discarded as a newly recognized homonyn and is replaced by *B-us* 1930, should B-idae be the family name? It seems simpler and more consistent with the underlying principles of nomenclature to use C-idae in either case.

The one rule specifically applying to names above family rank is that they shall be uninomial. There seems to be general agreement that although it is desirable to use the older of two synonyms, other things being equal, it is not absolutely essential, if usage has established the later name. For example, Rodentia Smith 1827 is generally used in preference to Glires Linné 1758, and Carnivora Latreille 1825 instead of Ferae Linné 1758. There can be no serious ambiguity in the use of a better-known synonym of later date, but the situation is decidedly different if a homonym is used. The International Rules condemn homonyms for generic and specific names, explicitly and unreservedly. It would seem as if the grounds were equally cogent for the larger groups. To give specific examples, the name Cyclostomata Busk 1852 for a bryozoan order is an exact homonym of Cyclostomata Müller 1834 (= Cyclostoma Rafinesque 1815, also Cyclostoma Latreille 1829, preoccupied by Cyclostoma Lamarck 1801), the lampreys and their relatives. Decapoda Leach 1817, as a subdivision of the cephalopod mollusks, is preoccupied by Decapoda Latreille 1806 in the Crustacea. Tardigrada Illiger 1811 for the tree sloths has precedence over Tardigrada for the water-bears, a Latinization of "Tardigrades" Doyère 1840 (from "le tardigrade" of Spallanzani). In some cases the French form was in use earlier than the date given, but in no case could it reverse the technical priority, as not in Latinized form, nor does it reverse the essential priority, unless, by a stretch of the imagination in the case of "le tardigrade," which is used in the singular referring to an individual and not as a group name. In the case of "Cyclostomata" and "Decapoda," the earlier usage is quite certainly more wide-spread than the later homonym; this is probably not the case with "Tardigrada." In any case, the use of the identical name for entirely distinct groups, besides being slovenly, is a source of possible confusion, especially in bibliographic work. It would seem desirable to discontinue the use of the later term, replacing it with the earliest or best-known valid synonym (for example, Tubuliporina Milne Edwards for Cyclostomata Busk), or if none is available, by a new term.

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THE ORIGIN OF SYMPHORICARPUS

IN a paper entitled "Chromosomes and Phylogeny in Caprifoliaceae," by Karl Sax and D. A. Kribs, published in the *Journal* of the Arnold Arboretum,[1] the authors point out that the genus *Symphoricarpus* is represented in China by only one species, of very limited distribution, whereas the other species are, all of them, natives of North America. Since most of the genera of Caprifoliaceae are most abundant in Asia, and certain genera are found only in China, "it would seem probable," they say, "that the family is of Asiatic origin."

On this assumption they ask the question, "Does this mean that the genus is so old that the original Oriental forms have disappeared and only the newer American species remain?"

Is it necessary to assume that there was ever more than one species of the genus in China? Alternatively may there not have been in North America a species (allied to or even conspecific with the Chinese species and coeval with it) which died out, perhaps through climatic changes? This hypothetical species, now defunct, may first have produced offspring some of which were better adapted to the American climate. By isolation, or otherwise, such species might, conceivably, have given rise to the fifteen (or so) existing American species, which may not all be of equal age.

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ENTROPY AND ORGANIZATION

THE growth of physical concepts depends on the conditions under which they arise. As the context of ideas and experimental facts changes, these concepts also change. From this point of view, it is easy to see how the physical or mathematical probability of an event depends on the assumptions or conventions under which it is calculated. Further,

[1] *Journal* of the Arnold Arboretum, Harvard University, 11 (No. 3): 147–153, July, 1930.

probability depends on the extent of our knowledge of the phenomena in question. This fact has been brought clearly to our attention in the formulation of new statistics by Bose and Einstein, Fermi and Dirac, but has also been pointed out recently in general terms, by Lotka, Eddington and Fry. For definiteness we shall, in what follows, think of the probability of a state as the fraction of the total time of observation in which this specified state is realized. However, such limitation is not necessary for our reasoning, which depends solely on the nature of the mathematical probability.

Though this arbitrary nature of the probability concept has been repeatedly commented on, it does not seem to have been sufficiently emphasized that entropy, being derivable from probability by the Boltzmann formula, is to the same degree indefinite or a matter of convention.

Probability is always "probability-in-the-light-of-certain-kinds-of-facts," those facts, for the physicist, being chosen with reference to energy availability. In a paper at present in course of preparation it is proposed to remove this limitation from the ideas of probability and of entropy and thus permit the extension of these concepts (if necessary, under different names) to aspects of biology and psychology in which the purely physical method of abstraction may not be entirely adequate. Entropy enables us to deal with the organization of inorganic systems but provides a very crude measure for the kind of organization found in living cells and organisms. The use of available energy to produce mechanical work is only one of the activities for which living systems are organized—and not necessarily the most important. By modifying the basis on which our probability is calculated we arrive at a more catholic interpretation of "entropy" by which we can avoid the error of confining our attention only to those aspects of the organism susceptible to analysis by the methods already found successful in much less highly organized matter.

It is suggested therefore that a differentiation be made between the thermodynamic "order" or "disorder" which are measured by classical entropy, and an "organization" or "disorganization" which do not ignore the physiological or psychological features of a given situation and which take account of them in the calculation of the probability.

That there is, in thermodynamics, always an infinite number of expressions homologous with entropy has been pointed out recently by H. J. Brennen, of Northwestern University. We have, in the past, chosen the simplest integrating factor $(\frac{1}{RT})$ for the equation of state of a perfect gas, and thus the entropy obtained is the simplest of these expressions. There is, however, no reason to suppose that nature is interested only in the simplest. Thus, even in the field of thermodynamics itself, there is an arbitrariness about entropy that parallels the above statistical considerations. As this equation has been set up on the basis of purely physical observations the entropies obtained can be measures only of "order" as defined above and not of the more general "organization."

One consequence of this point of view is a realization that the amount of internal energy in a system *actually transformed into work* depends not only on the entropy of the physicist but is subject to the interference of mechanisms, lifeless or living, and of intelligence. Maxwell's demon is the abstract prototype of such mechanisms, which we may call "selecting" mechanisms. They are divisible into two classes according to whether or not they may violate the second law. From the point of view of classical entropy, only the fictitious demon (which bases its action on observations of the microscopic state) can reverse the second law or increase the "order." The other ("valve") mechanisms, which depend for their action on the value of a macroscopic variable, may control the rate at which entropy increases or—more important for the present argument—determine whether or not the available energy will be used at all. Without deciding whether or not the latter mechanisms can interfere with the second law, it is surely desirable to recognize their existence and power to affect the probability and therefore to determine the fate of the energy. There can be no question that they control the more general "organization" of which we have talked.

These ideas throw some light on the so-called "thermodynamic improbability" of the origin and continuous functioning of living organisms. Such systems are improbable only in so far as we are unaware of all the factors operative, including the factors which "emerge" within the system at higher levels of organization in virtue of that organization. The apparent improbability of the organization found in biological structures is duplicated, on a lower level, in simpler systems. For instance, colloid, crystal and surface formations often present a disconcerting degree of organization for which, however, physical chemistry has no terminology at present. This can arise only from the action of the fields of force of the molecules themselves ("selecting mechanisms" for our purpose) and complexity is possible whenever they have free interaction. Such mechanisms can produce this order only at the expense of decrease of order elsewhere in the system. On the other hand, a

biological mechanism can influence the "organization" of matter foreign to itself and therefore may affect the "generalized" entropy.

These considerations are even more striking if the organism acts on the environment by way of its intelligence. Thought interferes with the probability of events, and, in the long run therefore, with entropy. The reason that this fact has escaped the physical analysis is that the physicist intentionally ignores organization which is not primarily organization for energy-availability and admits, further, available energy only in the sense of "available, if we care to, or are clever enough to, apply it for the performance of mechanical work." Actually such energy is available only if suitable mechanisms or intelligence intervene.

The idea of this note and projected paper is to relegate availability of energy to a place compatible with its biological and psychological significance.

I wish to thank Professor K. F. Herzfeld, of the Johns Hopkins, for his great help in the clarification and formulation of my argument and for his criticisms of the present note.

DAVID L. WATSON

ANTIOCH COLLEGE,
FEBRUARY 24, 1930

SPECIAL CORRESPONDENCE

RESEARCH WORK OF THE MICHIGAN COLLEGE OF MINING AND TECHNOLOGY

THE departments of physics, geology and electrical engineering of the Michigan College of Mining and Technology are cooperating this summer in continuing the study of the electrical resistibility of various rock formations in the iron and copper districts of Michigan. The work is a part of the general research program of President W. O. Hotchkiss to concentrate research at the college along lines which will be of greatest assistance to the mining industries of the state.

The object of the research studies is to obtain more intimate geological information concerning the districts. This information will be of value in directing exploration in the future.

Professors James Fisher, C. George Stipe, John M. Gaffney and William Longacre and a corps of student assistants of the physics department are studying the electrical resistibility of various formations in the field. This work is being carried on in the region close to the college where conditions are fairly accurately known, but it is planned to extend the research into the iron country. Present indications are that by this method it will be possible in many locations to determine the depth of the water table without drilling. It appears that different kinds of rocks possess different properties of electrical resistivities, and so it is possible by this method to determine geological formations which are covered to a considerable extent with glacial deposits.

In coordination with the work being done by the physics department in the field, Professors Fay L. Partlo, John M. Harrington and T. C. Sermon are in Madison, Wisconsin, doing graduate work in physics for advanced degrees at the University of Wisconsin. They are carrying on research investigations in connection with the physics of rock formations in the upper peninsula which will fit in with the general geophysical research work being carried on at the college. One of the problems which they are studying is the magnetic permeability of different rocks. This study is undertaken to get scientific facts underlying the striking variation in magnetic attractions being used in mapping the geology of the various districts.

Professor C. O. Swanson, Joseph L. Adler and Vincent L. Ayres, of the geology department, are engaged in field geological studies in the iron districts. This work has been going on for the past two years and considerable new information regarding the geological structure and currents in the iron formations has been obtained.

Professor Wyllys A. Seaman, also of the geology department, is engaged in field geological studies in the Copper Country in cooperation with the State Geological Survey and the mining companies. Frank Pardee, assistant state geologist, is in charge of this work. This group of scientists cooperating with the Mohawk Mining Company recently completed a survey of the New Michigan exploration where some valuable information was obtained.

Professor George W. Swenson, head of the department of electrical engineering, is carrying on research work in the American Bell Telephone Company laboratories in New York City. His department is cooperating with the telephone company in trying to determine what causes variations in the strength of radio signals, or why radio signals come in strong sometimes and weak at other times. The Copper Country offers unusual opportunities for this study because the rock formations of this district are of such a nature that there are strong local variations in the earth's magnetic field. These same variations are being used successfully in the geographical mapping of the district.

A CORRESPONDENT

SCIENTIFIC APPARATUS AND LABORATORY METHODS

ANALYSIS OF VOWELS

THE usual analyses of sustained vowels show characteristic distributions of energy on the frequency scale. It has been impossible to make entirely satisfactory syntheses of vowels by combining such fixed, "characteristic" distributions, either through the use of electric oscillators or by means of models of the vocal organs in position.

Furthermore, it is recognized that analyses of vowels based upon such steady-state conditions are not applicable to every-day speech. At the usual rate of enunciation of from four to eight syllables per second it is obvious that steady-state conditions are rarely approximated.

When the orifice and volume of the physiological resonator, the mouth, are varied during the progressive opening of the lips in saying the word "pope," the characteristic resonance frequencies must change rapidly while approximating the steady-state distribution. A similar change will occur at the close of the vowel. These transients constitute a temporal pattern not related to the cycles of the cord tone but an important part of the vowel.

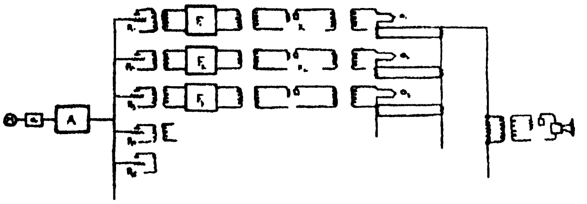
The physiological resonator may not come to a fixed position in the whole course of the spoken or even of the sustained vowel. In the case of the sustained vowel there is always the tremor factor in the fixated muscles of the resonator and in the chest muscles supplying the air-pressure. The pattern of the spoken vowel is certainly one of continuous change.

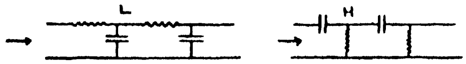
The vowel in rapid speech must be characterized by a perceptual time pattern of .025 to .200 second duration—a pattern composed of the characteristic transient or transients with their partials in intensity variation. The pattern is to be regarded as an envelop rather than as a group of simultaneous frequencies.

The accompanying diagram indicates a method in process of development for studying the time pattern of the vowels in rapid speech. The disposition of the units is the suggestion of M. S. Mead, of the General Electric Company.

A series of electric filters, perhaps of the resistance-capacitance type,[1] which will be selective for the transient as well as for steady-state pulses, is arranged to pick out bands from the frequency scale. The pulses passing through each of these filter bands are recorded by an individual oscillographic unit.

[1] Shea, "Transmission Networks and Wave Filters," p. 414.





"M" is condenser microphone with associated small amplifier (a) leading to the larger boosting amplifier (A). "R"s are repeater tubes which avoid throwback on the primary circuit—thus making it possible to use one or all filters ("F"s) separately or simultaneously. "X"s are tubes operating oscillographic units ("O"s). The last part of the circuit is an arrangement for synthesizing the analyzed currents. "L" and "H" refer to general type filter circuits (resistance and capacitance).

The parallel tracings of the oscillographs will show the varying intensities of the frequency bands from moment to moment during the course of the vowel. Thus the tracings will give indications from band to band of the time pattern of the transients composing the vowel. Rapid comparison should be possible for a large number of examples of the same vowel or of the different vowels.

The apparatus is so arranged that the pulses passed by the filters can be synthesized and the result of the analysis checked by the actual sound of the vowel which passes through the loud speaker.

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AN ELECTROMAGNETIC PUMP

A DESCRIPTION of an electromagnetic all-glass pump was published recently in this journal[1] by Mr. Henry Rosenberger. It may be worth while to point out that an almost identical piece of apparatus was described in 1926 by Porter, Bardwell and Lind.[2] A double-acting modification of this type of pump was devised by Funnel and Hoover in 1927,[3] and was later improved by Livingston.[4] While the authors of these earlier references were primarily interested in pumps

[1] H. Rosenberger, SCIENCE, 71: 463, 1930.

[2] Porter, Bardwell and Lind, *Journal Ind. Eng. Chem.*, 18: 1086, 1926. See also Francis, *Fuel*, 5: 39, 1926.

[3] Funnel and Hoover, *Jour. Phys. Chem.*, 31: 1099, 1927.

[4] Livingston, *Journ. Phys. Chem.*, 33: 955, 1929.

for circulating gases, only minor changes are necessary to render the apparatus described by them efficient for circulating liquids, as was pointed out by Funnel and Hoover. A single valve, probably less efficient, electromagnetic all-glass pump for circulating liquids was described by Smith and Wood in 1923.[5]

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SPECIAL ARTICLES

ON THE CRITICAL TEMPERATURE OF SERUM: DEPOLARIZATION FACTOR AND HYDRATION OF SERUM MOLECULES

IN a series of papers published recently[1] we have shown, successively, first, that the curve representing the viscosity of serum as a function of temperature presented an absolute minimum around 56° C.; second, that the curve expressing the rotatory power of serum, unaffected by heat up to 54°, suddenly showed an increase around that temperature, and that the subsequent increases were nearly proportional to the temperature; third, that the amount of light scattered at right angles by the serum also began to increase after 55° had been reached.

By application of Lord Rayleigh's formula connecting the amount of scattered light to the volume of the scattering particles, this last value was computed and was shown to increase almost linearly with the temperature, above 57° C. The purpose of this paper is to summarize the results obtained by measuring the depolarization factor of the scattered light. It is known that this light is almost completely polarized vertically in colloidal solutions and that the amount of depolarized light depends on the size, the shape and the anisotropy of the molecules or particles. It is difficult to estimate the part played by the shape, when dealing with particles which are not opaque; Cabannes has shown that, in the case of open chain hydrocarbides, the depolarization factor was independent of the length of the chain.[2] It is therefore probable that the main factors are the size and the optical anisotropy.

It was found that the depolarization factor ρ begins to increase, just as do the physical properties quoted above, after a certain temperature is reached, namely, 57° C. Its increase is slow at first, then very rapid, and its value may reach 0,50 for pure serum heated for ten minutes at 68°. The increase is continuous, and shows no jump when the sol becomes a gel. After the gel state is attained, the increase goes on, regularly, just as the increase in volume of the molecules, computed from Lord Rayleigh's formula. Table I gives the figures for a normal horse serum, heated ten minutes in sealed tubes.

TABLE I

Temperature	Norm.	55°	58°	60°	62°	64°	66°	68°
ρ	0,0175	0,0170	0,0191	0,0282	0,0490	0,0725	0,0832	0,467
								coagulated

When the serum is diluted with saline solution (0,9 per cent. NaCl) the depolarization factor may reach, for ten minutes heating at 76°, the extremely high value $\rho = 0{,}810$. In this case the amount of polarized light amounts to less than 20 per cent. of the scattered light.

If an attempt is made to explain the behavior of serum proteins in the aforesaid experiments (viscosity, polarized light, scattered light) it becomes soon obvious that hydration is the main factor. But in order to account for the quantitative side of the phenomena, it is necessary to resort to a new hypothesis concerning the mechanism of hydration. We have shown previously that, after a certain temperature was reached, the rotatory power and the volume of the molecules increased very nearly proportionally to the temperature, and that below a certain temperature nothing happened. We find now that the optical anisotropy of the molecules, expressed by ρ, increases very rapidly also. If the water molecules were adsorbed at the surface of the protein molecules, these facts would not be comprehensible. If on the contrary we assume that the water molecules can penetrate inside the huge molecular structure of the protein, and in doing so, change the relative position of the groups, the optical phenomena become quite clear. This hypothesis has the further advantage of

[1] P. L. du Noüy, *Ann. Inst. Pasteur*, 42: 742, 1928; 43: 749, 1929; 44: 109, 1930; *J. Gen. Phys.*, 12: 363, 1929.

[2] J. Cabannes, "La diffusion moléculaire de la lumière," p. 135, Paris, 1929.

[5] Smith and Wood, *Journ. Am. Chem. Soc.*, 45: 2632, 1923.

explaining the reason of a threshold, around 55° C., and the proportionality to temperature of the phenomena: as long as the kinetic energy of the water molecules does not reach a certain value, the forces binding the external groups of the protein together will not let them in. When the critical temperature is reached, it simply means that the kinetic energy of the water molecules is of the same order of magnitude, and that they can force their way through. From that moment on, the amount of molecules which will penetrate is directly proportional to their energy, that is to say, to the temperature. The volume of the protein molecules will then increase until they occupy the whole volume of the solution: the sol becomes a gel. As the concentration of proteins in horse serum, for instance, is high (about 7 per cent.), and as the volume occupied by these molecules, expressed in per cent. of the total volume, is roughly equal to 11, it means that if the molecules of protein increase their volume nine times, they will be in contact with no free solvent between them; in this case, their mean diameter is only increased about twofold. Such an amount of hydration (900 per cent.) is not at all in contradiction with what is known concerning the capacity of hydration of proteins. Marinesco[3] has found for egg-albumin values as high as 1.300 per cent.

A detailed paper will appear shortly and bring forth a few more facts in favor of this hypothesis.

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ELECTROMAGNETIC RADIATION AND THE PROPERTIES OF THE ELECTRON

THERE is weighty evidence, I have shown,[1] that the link between electromagnetic radiation and the electron, which engages the attention of physicists very much at present, is represented by certain properties of the electron. I would like to point out here additional evidence. Consider an electron gas kept at constant temperature, through which two beams of *continuous* electromagnetic radiation of equal intensities parallel to each other are passed in opposite directions. Suppose that the electrons consist of perfectly reflecting particles. On account of their motion the radiation will exert a pressure tending to decrease their velocities continually. But on the average this can not happen. The electrons therefore regain their velocities during the collisions, which can happen only through an increase of their fields during the process; and hence their fields decrease during the intervals between collisions. The increase in electric potential energy during the collisions can be derived only from the internal energy of the electrons, which can be replenished only through an absorption of radiation, into which the kinetic energy lost was initially converted. The electrons thus absorb radiant energy during their motion which is stored up as internal energy and which is attended by a decrease in their electrical fields.

Now suppose that the intensities of the two beams are varied in such a manner that the velocity of a selected electron of the gas is not influenced through the change of the distribution of the pressure of the beams and surrounding radiation acting upon the electron. If further we suppose that the absorption of radiation takes place in such a manner that no force is exerted upon the electron, it would proceed indefinitely with a constant velocity while absorbing radiation, whose total amount may become infinitely large. But this is impossible. Hence the absorption of radiation takes place asymmetrically and in such a way that a force is introduced acting contrary to the motion of the electron, and in a degree that when the motion is reduced to zero the absorption ceases. Hence if v_0 denote the velocity of the electron at the beginning and v that at the end of a free path, the change in momentum under these conditions is given by

$$m\,(v_0 - v) = k_1\, h\, \Sigma\, k_2\, \nu/c$$

where m denotes the mass of the electron, h Planck's constant, c the velocity of light, ν the frequency of radiation, and k_1 and k_2 denote constants. The amount of internal energy converted during the collision at the end of the path into kinetic energy and radiation by acceleration will be less than twice the change in kinetic energy, since the acceleration is produced by a recovery of the field. The difference

$$k_3\, h\, \Sigma\, k_2\, \nu - m\,(v_0^2 - v^2)$$

is therefore the minimum amount of internal energy that at some part of the path (probably where collision occurs) is reconverted *directly* into radiation, where $k_3\, h\, \Sigma\, k_2\, \nu$ denotes the energy absorbed over the path, k_3 being a constant equal to or greater than k_1. This expression may be written

$$\Big(k_3\, c - k_1\,(v_0 + v)\Big)\frac{h\, \Sigma\, k_2\, \nu}{c}$$

by means of the above equation. It is evidently a positive quantity, and electronic internal energy is thus converted *directly* into radiant energy under these conditions. They will, no doubt, occasionally be satisfied by the radiation surrounding an electron without any external assistance. Internal energy will also obviously be directly converted into radiation

[3] N. Marinesco, *C. R. ac. Sc.*, 189: 1274, 1929; 187: 718, 1929.

[1] *Phil. Mag.*, 7: 493, 1929; SCIENCE, 70: 478, 1929; 61: 340, 1930; *Nature*, 124: 728, 1929.

whenever the radiation absorbed by an electron in passing over a free path is greater than the increase in kinetic energy and energy radiated through acceleration during collision.

If the electron consists of a packet of radiation, as de Broglie and Schrödinger suppose, it is all the more likely to possess the above properties.

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INTERPRETATIONS OF THE CURVE OF NORMAL GROWTH

ALTHOUGH there seems to be a striking similarity between the course of growth in animals and plants and the courses followed by the autocatalytic curves as described by Robertson[1] and Crozier,[2] it seems doubtful whether such a complicated process as growth would follow so simple a chemical reaction. A growth equation embodying a general biological rather than a chemical interpretation of the growth process may be derived in the following manner. Minot[3] showed for a number of animals that the percentage increments in body weight $\frac{W_2 - W_1}{W_1}$ tend to decrease constantly from birth to maturity. Child[4] explains this decrease in the percentage increments as due to the ever-increasing mass of inactive protoplasm in the body cells accompanying growth and differentiation. As the mass of inactive protoplasm increases, the mass of active protoplasm decreases and hence the relative rate of metabolism decreases, which in turn brings about a decrease in the reproductive or growth power of the cells. These percentage increments may be looked upon as measuring the average growth power of the body cells, if growth power may be defined as the percentage rate of increase in growth. Wright[5] suggested briefly that the hypothesis that growth power falls off at a constant percentage rate leading to the curve

$$\log \log \frac{c}{W} = a - kt \qquad (1)$$

might often give a good fit to growth data. This equation may also be expressed in the forms

$$\log W = A - be^{-kt} \qquad (2)$$

and

$$L = Be^{-Ce^{-kt}} \qquad (3)$$

Dr. Wright found that equation (1) gave a very good fit to growth in weight W of rabbits. Equation (2) was found by Davidson[6] to give a good fit to growth in weight W of dairy cattle. Equation (3) was applied by Weymouth[7] with excellent success to growth in length L of the razor clam.

The derivation of equation (2) is as follows: $\frac{dW}{Wdt} = P$ where W equals body weight at any time t, and P equals the growth power of the body cells. Since growth power is assumed to fall off at a constant percentage rate, $\frac{dP}{Pdt} = -k$. By integration $\log P = -kt + C$, or $P = e^{C-kt} = \frac{dW}{Wdt}$. By integration again, $\log W = -\frac{1}{k}e^{C-kt} + A$, or $\log W = A - be^{-kt}$. In the last equation A is the logarithm of the weight of the animal at maturity; 100k is the constant percentage rate of decrease in growth power according to the above interpretation, and b locates the curve in time; W is the weight at any time t. The equation of the curve for weight W is $W = e^{A - be^{-kt}} = Be^{-be^{-kt}}$ where $e^A = B$. This equation is similar to equation (3) for length L and is S-shaped with the point of inflection at approximately 37 per cent. of the final weight. It differs from the growth curves of Robertson and Crozier in that it embodies a general biological rather than a chemical interpretation of the growth process and at the same time requires the utilization of fewer velocity constants.

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[1] T. B. Robertson, *J. Gen. Physiol.*, 1925–1928, 463, 1926.
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SIZE AND FORM IN PLANTS[1]

By Dr. F. O. BOWER

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Two years have passed since the association last met in Britain. Events have happened in that interval which mark the close of the Darwinian Epoch. Down House, in which Darwin lived and worked, has been bought, restored and endowed by Mr. Buckston Browne and presented by him to the association, who hold it in custody for the nation. The house is now open as a shrine to those who treasure Darwin's memory. They may enter the study where the "Origin of Species" was penned, or wander out to the Sand Walk, and draw such inspiration as those spots may yet afford to those who are face to face with problems cognate to his own. These years have also severed personal links with Darwin himself. Sir William Thiselton-Dyer, who died in December, 1928, had been his frequent correspondent. It was he who, more than any other, carried the evolutionary stimulus forward into the botanical schools of Britain. Sir Edwin Ray Lankester, whose portrait by Orpen was a poignant feature of last year's academy, died in August, 1929. Not only was he the leading zoologist of his time, but he has left a deep impress on general morphology, for he was the first to analyze from the evolutionary aspect the degrees of "sameness" of parts, whether in animals or in plants. These two octogenarians were among the latest links between Darwin himself and living men of science. And so this last meeting of the association before its centenary next year falls at a nodal point in the personal history of evolution.

Morphology, or the study of form, was closely interwoven with the life work of Darwin, and—to

[1] Address of the president of the British Association for the Advancement of Science, Bristol, September 3, 1930.

use his own words—"it is one of the most interesting departments of natural history, and may almost be said to be its very soul." Since the association has seen fit to choose as this year's president a botanist whose work has dealt specially with form in plants, the occasion seems apt for considering certain morphological questions that present themselves in this eighth decade since the "Origin of Species" was published.

The word morphology was applied by Goethe in 1817, in a general sense, to the study of form. Though a pre-Darwinian, he showed rare foresight in insisting that the living form is only momentarily stable, never permanent. But years elapsed before that instability of form of living things, which he clearly saw, became the very focus of evolutionary theory. Even Goethe's prophetic gaze was blurred by the hazy imaginings of idealistic philosophy. The clarifying mind of Schleiden resolved that mist by resort to naked fact. In 1845 he stoutly asserted that the history of development is the true foundation for all insight into living form. This opened the way for a host of workers, who patiently observed and compared the facts of individual development, particularly in plants of low organization. By them the field was prepared for the magic touch of Darwin, and in the enthusiastic words of Sachs, "the theory of descent had only to accept what genetic morphology had actually brought to view."

The effect of that theory should have been to sweep aside all idealistic morphology based on the higher forms, and to rivet attention upon organisms low in the scale. It was the habit of starting comparison from the highest state of organization that was the fundamental error of the idealistic nature philosophers; even now traces of it still persist. An illuminating alternative was presented by that noble passage with which the "Origin of Species" ends. Speaking of his theory, Darwin wrote: "There is a grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms, or into one; and that—from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved." He forecast from the application of his theory that "our classifications will come to be, as far as they can be so made, genealogies; and they will then truly give what may be called the plan of creation."

Whether there was only one original form of life or many is still an open question. Nevertheless, among the welter of organisms rightly held as primitive, the Flagellata may with some degree of reason be named as combining in their motile and sedentary stages respectively the animal and vegetable characters. They suggest a sort of starting-point from which the two kingdoms might have diverged. The probability of their common origin is strong; but the divergence must have been early, each taking its own independent course, with increasing size and complexity of the individual. In tracing this I would ask your special attention this evening to the kingdom of plants.

The first of the laws laid down by Lamarck[2] in his "Histoire Naturelle" as fundamental in the evolution of animals and plants ran thus: "Life by its intrinsic forces tends to increase the volume of every living body, and to enlarge its parts up to a limit which it determines itself." When in unicellular organisms, following this law, a certain size has been reached, fission follows, and the equal halves separate as new individuals. In pluricellular bodies, however, the products of cell-division do not separate, but continue a communal life; and the individual may increase, with further division of its cells, to large size and complexity. We may picture how, based upon the mobile stage of a flagellate, the aggregate might form an animal body with motility as a leading feature; on the other hand, based upon the sedentary stage, an immobile plant-body would result. The animal, adopting a predatory habit and colorless, might progress along lines of dependent nutrition, finding and ingesting food already organized; the sedentary green plant might evolve along lines of physiological independence, constructing its own organic supplies. Whether or not this be a true picture, the whole organization of the two kingdoms diverged on the basis of nutrition. Herbert Spencer contrasted them physiologically, showing how animals are expenders, while plants are accumulators; that the former are limited in their growth by the balance of expenditure against nutrition; in the latter growth is not so limited. Thus the problems that follow on increasing size may be expected to work out differently in view of the animal kingdom comprising organisms of high expenditure and not self-nourishing, while plants are self-nourishing accumulators.

The result of this difference may be illustrated by contrasting some of the highest examples of either kingdom; for instance, the elephant with the trees of the forest through which he roams. On the one hand, the relative fewness of the mobile elephants, their less stature and compact form, their columnar legs needed to support the barrel-like body, the receptacle for ingested food, the economy of external surface and the highly developed internal surfaces. On the other hand, the height, immobility and large number of the trees, with their massive stems and

[2] Lamarck died in 1829, and the association has contributed to a fund being raised for a memorial by the Linnean Society of Northern France.

highly complex shoots and roots, so necessary for acquiring food directly from the air and soil. We may further contrast the genesis of the individual in either case. In the mammal the parts are formed once for all, its embryology being an incident closed early in the individual life; but in the tree embryology may be continued for centuries, and is theoretically unlimited, except by death; during life it has the power of producing leaves and branches from every distal bud. The fact is that, though certain underlying principles are the same for both kingdoms, the working out has been distinct from the first. Hence the morphology of plants must stand on its own feet; indeed it has been said with some degree of truth that whenever botanists have borrowed their morphological outlook from the sister science they have gone wrong.

The normal development of a multicellular plant starts from the fertilized egg, and elaboration both external and internal follows on increasing size. Polarity, that is, the distinction of apex and base, is defined in most plants of high organization by the first cell-cleavage. The apex adopts at once the continued development that is its characteristic. Branching of various types follows in all but the simplest, to constitute the complex shoot, while correlative basal branching gives the root system that fixes the nonmotile body in the soil. The scheme of growth and branching thus started is theoretically open to unlimited increase, and the initiation of new parts is in point of number on a geometrical scale. This is suitable enough for organisms able to accumulate material, as plants do; indeed, the elaboration of the vegetative system will enhance its powers of self-nutrition, so far as the parts become functional; but this is never fully realized beyond the earlier steps.

The focus of all such development is the growing point, respectively, of root or shoot. Any one who carefully dissects a suitable bud, peeling off the successively smaller leaves, may finally see with the naked eye or with a simple lens a pearly cone of semi-transparent tissue at the tip of the stem. This is the growing point itself, which possesses theoretically unlimited formative power. It is like a permanent sector of the original embryo that is fed continually from the mature tissues below, and as continually forms fresh tissues at the tip. But as the tip advances, lateral swellings of the surface appear in due order, which are new leaves and buds. Various attempts have been made to link the genesis of these outgrowths of the radial shoot with the outer world as regards their position and number. But we have it as the latest authoritative statement on this point that such a relation does not exist. "This much is proved," says Professor von Goebel, that, "so far as we can see, the question relates to conditions of growth and symmetry that arise in the growing point. . . . All theories as to leaf position that allotted a passive rôle to the growing point were mistaken, however acute the reasoning that was brought to bear thereon."[3] This is von Goebel's summing up for external parts. On the other hand, within the growing point, and often, though not always, related to the external parts, there is a progressive formation of internal conducting tracts, continuous from the adult region upwards to the tip. A like reference of the origin and disposition of these vascular tracts to the growing point itself appears to be equally justified. In fact the tip possesses the initiative for both.

The complex shoot that results from such initiation is exposed as it matures to external conditions which modify its form. Their effect is very obvious in the young shoot of the higher plants. As the shoot elongates its young tissues are soft and plastic. While in this state its form may be influenced by gravity, the incidence of light, mechanical contact and other causes which produce reactions of form called "tropisms." All these promote the well-being of the whole. The net result becomes fixed as the part matures, and its constituent tissues harden. Thus the adult form is the consequence of the primary initiation at the growing point, modified by the conditions to which the plant may have been exposed during the plastic period. This is a commonplace of the text-books. But amid all the careful analysis and experiment that has been devoted to the influences which thus affect form, one factor, insistent and unavoidable, has been habitually left out, *viz.*, the influence of size. Reference is occasionally made in text-books to the effect of surface tension in determining the simple form in minute organisms, such as unicellular algae and bacteria, and to the deviations from that simple form as the size increases and the influence of surface tension ceases to be dominant. At the other end of the scale of size mathematicians have calculated the extreme stature mechanically possible for a tree-trunk constructed after the ordinary plan, and of materials of known strength. The result is about 300 feet, and this coincides approximately with the limit of height of the canopy of a tropical forest. But in point of size practically the whole of the vegetable kingdom lies between the microbe and the forest tree. Unfortunately the study of these middle terms, from the point of view of change of form as the size increases, has not been pursued by botanists with the same perception as zoologists have shown in the study of animals.

At the back of all problems raised by increasing size stands the well-known principle of similarity,

[3] "Organographie," third edition, Part I, pp. 299–300.

which applies to all structures, inorganic as well as organic. It involves among other consequences that where form remains unaltered bulk increases as the cube, but surface only as the square of the linear dimensions. But in living organisms it is through the limiting surfaces, or "presentation surfaces," as they are called, that physiological interchange is effected. Provided a surface be continuous and its character uniform, it may be assumed that such interchange will be proportional to the area of surface involved. If, then, the form of the growing organism or tissue were retained as at first—for instance, a simple sphere, oval or cylinder—its surfaces of transit would increase at a lower ratio than the bulk which they enclose. There would be with increase in size a constantly decreasing proportion of surface to bulk, and as constantly an approach to a point of physiological inefficiency. But any change from a simpler to a more complex form would tend to uphold the proportion of presentation surface. Thus the success of a growing organism might be promoted by elaboration of form. Naturally other factors than that of size cooperate in determining form. Nevertheless the recognition of such elaborations of form, whether external or internal, as do tend in point of fact to maintain a due proportion of surface to bulk as growth proceeds should help to make morphology a rational study. The diffuse form habitual for plants, even the origin of leaves themselves, becomes intelligible from this point of view.

In the construction of any ordinary vascular plant there are three of these presentation surfaces, or limiting surfaces of transit, that are of prime importance: (1) the outer contour by which it faces the surrounding medium; (2) the sheath of endodermis which envelops the primary conducting tracts, and (3) that collective surface by which the dead woody elements face upon the living cells that embed them, through which water and solutes pass in or out. Each of these may vary independently of the others, and each would be a fitting subject for observation as bearing on this problem of size. But as a test case of the relation between size and form, it is the collective surface where dead wood faces on living cells that will meet our requirements best, for its study can be pursued among fossils almost as well as in living plants. The problem is one not merely of current physiology of the higher plants; it is one of adaptive progress. Accordingly measurements must be made of the wood of fossils as well as of living plants, and of young sporelings as well as of the adult.

We have seen that plants are essentially accumulators of material. A natural consequence of this is that primitive types, endowed with apical growth but with no secondary cambium, will enlarge from the base upwards. Any sporeling fern shows this. The leaves themselves increase in number; each successive leaf is as a rule larger than the one that came before, and the stem that bears them also expands upwards. In fact it takes the form of an inverted cone. To grasp the size-problem for primitive plants the mind must be rid of the idea of the forest tree, with its stem tapering upwards, for that is a state of highly advanced organization. The primitive form of stem is that of an inverted cone, enlarging upwards, with a solid core of wood within. A cone standing upon its tip is obviously unpractical. Not only is it mechanically unstable, but if the original structure be maintained so that the larger region above is structurally a mere magnified image of the smaller below, a constantly diminishing proportion of presentation area to bulk must needs follow, in respect of all the limiting surfaces. Such stems would all tend to become physiologically insufficient. Our immediate problem is with the woody column. How can that due proportion of presentation surface of the dead wood to the living cells, which physiologists hold to be essential, be maintained in the expanding stem, so as to meet the increasing requirements of transit and distribution of the sap?

This is not the place for a recital of the details of elaboration of the wood which have been observed and measured. It must suffice to state in general terms how primitive woody plants have met the difficulty in the absence of cambial thickening. The starting-point is a minute cylindrical strand composed of dead tracheids only. Some primitive types show nothing more than a conical enlargement of this upwards, with the cells more numerous than before. The approach of a locomotive at speed along a straight track may visually suggest such increase in size without change of form; successive photographs of it might be compared with successive sections of those simple stems enlarging upwards without change of plan. The largest examples of this are found in some of the early club mosses and ferns, in which there is an enlarging solid woody core. But for want of resources in this and other features they have paid the penalty of death. Most plants having this crude structure are known only as fossils, and no really large vascular plant lives to-day which shows it. Under present conditions it is only where the size is small that a simple mass of dead tracheids seems to be effective for water transit. Thus we see that simple enlargement without change of form does not suffice.

In more resourceful plants a remedy is found in elaboration of the form and constitution of the pri-

mary wood. The changes which actually appear in it, as the size of the individual or of the race increases, are very various, but they all tend towards making the wood a living whole. The most efficient state would be that in which each dead woody cell or element faces upon one or more living cells, and this structure is approached in modern types of wood. In tracing the steps which have led towards it, whether in the fossil story or in the individual life of plants, we follow up an evolutionary history of high functional import. Actual measurements and calculations have shown in living plants the advantage that follows. It has been found that changes in the elaboration of form and structure of the primary woody column have saved, in specific instances, about 50 per cent. of the contingent loss in that proportion of presentation surface to living tissue which would have followed if a simple cylindrical core had been retained. The structural changes do not, it is true, maintain the full original ratio of surface to bulk, but it may well be that saving even half of the contingent loss would bridge the acute risk and lead to survival.

The molding and subdivision of the primary conducting tracts as a whole, or of the woody masses which they contain, present the most varied features. Their contours often appear arbitrary and even irrational, so long as no underlying principle is apprehended. They have presented a standing problem to anatomists. But when it is realized that as the size increases there is a physiological advantage in any elaboration of form whatsoever, a rational explanation is at hand. The variety of the forms assumed suggests the common principle underlying them all, which is that thereby a due proportion of presentation surface tends to be maintained.

One of the simplest and most frequent examples of such elaboration of form is that of the fluted column, which in transverse section gives the familiar stellate figure characteristic of roots. It is also seen in many stems, and is described as "radial." Where the part is small the woody strand is roughly cylindrical, but where larger it often becomes fluted, with varying number and depth of the flanges. In many instances the ratio of their number to the diameter of the whole tract is approximately constant. The structure is in fact adjusted to the size. This is so in roots generally, in leafy stems and in leafless rhizomes—and a similar size relation is even found in the fluted chloroplasts of certain algae. In all these an obvious risk following an increase in size tends to be eliminated, *viz.*, an undue loss of proportion of surface to bulk.

The somewhat technical facts thus briefly described may be taken as examples of a relation of form to size which is very general. They suggest the existence of a size factor, which is effective in determining form. The susceptibility to its influence resides in the part that shows the results. The internal contours are defined *ab initio,* instead of coming into existence during the course of development, as is the case with the convolutions of the mammalian brain. In the stem and roots of vascular plants the fully matured conducting tracts may be traced upwards, with their outlines already defined, through successive stages of youth towards the growing point, which has been their source. Their form may be seen already outlined in its young tissue closely short of the extreme tip. This fact suggests that the susceptibility to the size factor resides in the growing point itself, for immediately below it those tracts possess that form which will aid their function when they are fully developed.

Of all the factors that contribute to the determination of form in growing organisms there is none so constant and inevitable in its incidence as this size relation. Its operation becomes manifest with the very first signs of differentiation of the embryonic tissues. The effects of other factors that influence form, such as gravity, light, temperature, contact and the rest, appear later in point of time. Their influence is liable to diminish as the organism reacts to them by curvature or otherwise, and to vanish when the reaction is completed. Under experiment they may be controlled or even inhibited. But the operation of the size factor is insistent; it can not be avoided either under conditions of nature or by experiment, though the size itself may be varied under conditions of nutrition and the permeability of the presentation surfaces may not be constant, with results as yet unknown. When we reflect that all acquisition of nourishment and transit of material in plants of primary construction is carried out through limiting surfaces, the essential importance of the size factor is evident, for upon its influence the proportion of each presentation surface itself depends.

The evidence that size itself is, among other factors, a determinant of form rests upon the constancy with which, in an enlarging organism, changes of primary form tend to maintain a due area of presentation surface such as active transit demands. That evidence has been derived chiefly from the conducting tracts of primary individuals as they enlarge conically upwards, and from parts belonging to distinct categories, also from comparison of different individuals not necessarily of close alliance. Very cogent evidence lies in the variety of the changes of form by which the same end is attained. Finally the converse facts bring conviction when, as often happens, a distal diminution of size in stem or leaf is accom-

panied by simplification along lines roughly the converse of those that follow increase. All this shows that a real relation exists between size and primary form. The term size factor has been used to connote that influence which affects form in relation to size, but without defining it except by its results. Nevertheless, we have seen that its action may be located in near proximity to the growing point, or in the embryo itself. It has not, however, been found possible to assign to that effect an immediate cause. The attitude thus adopted towards an undoubted factor seems justified by the broad logic of science and by the practice of its highest votaries. When Newton put together his great physical synthesis he pointed out at the close of the "Principia" that the cause of gravitational force was unknown. "Hitherto I have not been able to discover," he said, "the cause of these properties of gravity from phænomena, and I frame no hypotheses." Likewise, in its own more restricted field of botanical phenomena, the size factor may be recognized as effective in development, though the immediate cause of its effectiveness is still unknown.

The position thus adopted assumes the shoot to be a unit, not a congeries of "phytons." The elaboration of its form, whether external or internal, would be a function of the increase in size of that unit, and the result would tend to maintain the adequacy of the presentation surfaces. This conception of the shoot and of its parts would accord with the views of General Smuts, as stated in his remarkable work on "Holism," published in 1926. Many present here to-day will have heard his address in Cape Town last year, when opening the discussion on "The Nature of Life." All will value this masterly statement in brief of his theory. I suggest that the operation of the size factor, whether in relation to external leaf development or in the elaboration of internal conducting tracts, illustrates that "measure of self-direction" ascribed by him to every living organism.[4]

The discussion of the problem of size and form in plants, which has occupied our attention thus far this evening, raises questions of profound significance in the sphere of pure botany. There is, however, another interest inherent in the study of plants beyond that of pure science. I mean botany as applied to the needs of man. To-day this touches human life more closely than ever before. Every meal we eat, many of the clothes we wear, timber, rubber—a whole volume in itself—the drugs, narcotics, dyes and scents, and most of that vast tale of accessories that ameliorate life, depend for their supply, quality and often for their existence upon the skilled work of the botanical expert. He is trained in our schools and universities. His experience there is perfected by work on farms and plantations, in forests and in factories, often by adventurous life abroad. It would be superfluous for me to enter into detail on such matters, for happily the director of Kew presides over the botanical section, and he can speak with the fullest knowledge on the application of botanical science to modern life.

Government departments are now linked more closely than ever with universities and technical colleges by the golden chain of grants. The botanical institutes that have sprung from this joint source are mostly focused at such centers as Kew and South Kensington, Cambridge and Oxford, Harpenden and Merton, Long Ashton and Corstorphine, Plymouth and Millport, with important outliers such as Dehra Dun in India, the Imperial College of Tropical Agriculture in Trinidad and the Research Station at Amani, East Africa, while similar stations are to be found in Canada, at the Cape, in Australia and New Zealand. Their activities are as diverse as their positions. Agriculture, forestry, plant breeding and distribution, seed-testing, mycology and plant pathology —these are but a few of the headings under which applied botany is now pursued; and a duly qualified staff is required for each. Kew itself, thanks to the foresight of the Empire Marketing Board, is developing ever more and more as a coordinating center for the whole empire. Highly specialized study such as this has sprung into existence in the last half century. As regards Britain, its origin may be traced to the biological laboratory of the old Normal School of Science at South Kensington, where biological research was revived under Huxley and Thiselton-Dyer.

The first botanist there trained in pure science who turned the newly acquired vision to practical account in the interests of the empire was Marshall Ward. For two years he investigated the coffee disease that had half ruined Ceylon. It is a long step from this individual effort in the East to the firmly established and efficient Mycological Bureau, recently housed at Kew in a new building devoted to the world-wide study of the fungal diseases of plants. Such advance along a single line of applied botany may be taken as an index of the progress from simple beginnings in pure botany to that wide-spread attack now being made upon the economic problems that face imperial agriculture. The history of it thus briefly suggested may be read as a parable, showing how natural is the progression from the study of pure science to its practical application. For there is no real distinction between pure and applied science. As Huxley told us long ago, "What people call applied science is

[4] "Holism," p. 98.

nothing but the application of pure science to particular problems."

At the moment there is an unprecedented demand for botanical specialists to fill investigational and advisory posts at home and abroad, and there is a shortage of applicants. The realization of this will doubtless be transmitted through the universities and colleges to the schools of the country and lead to an increased supply. On the other hand, it lies with the government to react as other markets do in taking steps to equalize supply and demand. A condition of the success of a specialist will always be a thorough foundation upon pure science, and this will be fully realized in the selection of candidates. Government, whether at home or in the wider imperial field, can make no better investment than by the engagement of the best scientific experts available. In respect of botany this has been attested by many well-known instances.

Some reference will naturally be expected here to the remarkable address given by Sir William Crookes in 1898, when the association last met in Bristol. He then forecast that, in view of the increase in unit consumption since 1871 and the low average of acre-yield, "wheat can not long retain its dominant position among the foodstuffs of the civilized world. Should all the wheat-growing countries add to their area to the utmost capacity, on the most careful calculation the yield would give us only just enough to supply the increase of population among bread-eaters till the year 1931. The details of the impending catastrophe," he remarked, "no one can predict, but its general direction is obvious enough." The problem is one of applied botany, with a setting of world economics and a core of physical chemistry. After raising the specter of wheat shortage before the eyes of his audience of 1898, Crookes laid it again by the comforting words:

> The future can take care of itself. The artificial production of nitrate is clearly within view, and by its aid the land devoted to wheat can be brought up to the 30 bushels per acre standard.

We who are living within a few months of the fateful year of 1931 are unaware of any wheat shortage. Sir William Crookes' forecast of 1898 as to the advance in the production of combined nitrogen has been fully realized. Artificial fertilizers are not in view only, but at hand and in mass. Moreover, the northern limit of successful wheat culture has been greatly extended by the production of new strains with ever-shortening period between sowing and reaping, while the establishment of new varieties is extending the productive area in South and West Australia into regions where the rainfall is of short duration and restricted in amount. The future, since 1898, has indeed taken care of itself; so that, notwithstanding the warning of so great a man as Sir William Crookes, the wheat-eating public is still able to sleep well at night so far as the wheat shortage is concerned. What better example than this could we desire, not only of the importance of applied botany, but as showing also how its advance follows on research independently pursued? For the production of synthetic nitrogen, which has now become a commercial proposition, and the improvement of the strains of wheat by selective breeding along Mendelian lines, are both involved in solving this crucial question of food-supply. And both owe their origin to advances in pure science.

In conclusion, we shall all be conscious of the fact that a most distinguished former president of the association has lately passed away, one who more than any man has influenced the policy of government in relation to science. I mean Lord Balfour. We recall how in 1904 he, so thoroughly imbued with the spirit of his alma mater, presided over the meeting in Cambridge. He was distinguished as a philosopher, great as a statesman, and particularly so under the stress of war. He it was who, after peace returned, used his rare influence in transforming the war-time experiment of a committee of the Privy Council for scientific and industrial research into a permanent and essential part of modern government. But this was not all. His critical, constructive and experienced mind was led to formulate a still wider plan. A Cabinet Committee for Civil Research was to be established on the lines of the Imperial Defence Committee. He designed it so as to bring the whole national administration within the range of scientific influence. The Department of Scientific and Industrial Research, so wisely kept in being after 1919, now forms part of that larger scheme. This department is responsible for making recommendations as to the expenditure of funds voted by Parliament for research, especially in relation to industry. Thus science is welcomed into the inner circle of imperial administration. This the state owes to Lord Balfour.

And so in this hundredth year of its existence the British Association sees research recognized and fostered in the service of the state in a way never dreamed of in 1831, when a small body of enthusiasts met at York for the advancement of science. But though the individual seeker after truth may thus be involved in official harness, as of old an inner voice will yet speak to him. He will himself be as near to nature to-day as he was in the simpler days that are gone.

MALPIGHI AS ANATOMIST[1]

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IN these crowded days it is easy to overlook or forget what one owes to the past. The present is vocal and urging; the past silent and patient. Besides, life is so many-sided that no one can realize fully his entire indebtedness to the past, although the higher a civilization, the greater this golden heritage always is.

It is fortunate that we are willing to pause in a hurried day in order to pay our respects to a searcher who labored with great enthusiasm to almost the very end of his life in order to enlighten man regarding his own body. The name of Malpighi can never become a household word, but the debt that every one owes him nevertheless is great. There are no greater triumphs than those over ignorance and helplessness, over barbarism and brutishness. Hence it will be a sad day for civilization when the Malpighis are forgotten.

Although we are observing the tercentenary of his birth, Malpighi does not belong to the ancients. He was a modern anatomist, not only in his methods but also in his attitude and outlook.

As anatomist, Malpighi was not an observer of the dead alone. He was an experimentalist who worked much with living creatures of different kinds. He used both vertebrates and invertebrates as well as plants, and felt that there was a kinship among all living creatures, so that one could learn regarding the higher from an examination of the lower forms.

During all the time that he was professor of medicine he earnestly tried to reveal and understand the architecture of beings of all kinds, and to this end he used the microscope, chemicals, pigments such as ink, and the processes of maceration, boiling, injection, ligation, dissection and vivisection. How modern he was can best be illustrated by the fact that an enterprising medical student who copied from Malpighi's works over two hundred years afterward is recorded as actually having received a prize for his contribution to science.

It seems regrettable that Malpighi's anatomical studies had to be done largely during vacations and spare hours, for his interests did not lie in the single lane of the anatomy of his day. Worms, insects, fishes, amphibians and mammals of many kinds claimed his attention. He made contributions to embryology and to both gross and microscopic mammalian and human anatomy, and was in a large measure a founder of embryology and of the microscopic anatomy of organs. Indeed, Sir Michael Foster in his "History of Physiology" states that where Malpighi left embryology, it remained till the beginning of the nineteenth century.

It is true that Malpighi was in a sense a preformationist, for he had concluded that the chick is present in the incubated egg. This erroneous conclusion rested upon the observation that when hen eggs which had lain in a warm climate for some time were opened, it was found that development of the new individual had already begun, as indeed it has by the time a fertilized egg is laid. Moreover, since we now know that not all the cytoplasm of an ovum has the same potentialities, it is clear that present-day ideas of development might in some measure still be regarded as embodying a preformation hypothesis, although our ideas contain none of the early implications, and could we but go back farther in oogenesis with our experimental efforts, we would no doubt reach a stage in development in which the segregation of developmental potentialities probably had not yet occurred.

When Malpighi saw something new he was not content until others also had seen it, and some of his great discoveries are recorded in letters to his friends. That he took keen delight in his work is shown by his declaration that "in performing these researches so many marvels of nature were spread before my eyes that I experienced an internal pleasure that my pen could not describe." This devotion to practical studies caused him to be ridiculed, and he, like his great predecessor Harvey, was taunted by being asked how dissecting plants and watching the eggs of silkworms and hens hatch could possibly help cure the diseases of man. It is a strange commentary on modern life that there are those among us who still ask this same outworn question.

Since the labors of great men of the past often seem magnified by our forgetfulness of other workers in their field of activity and their time, it is well to recall briefly some of Malpighi's approximate contemporaries in anatomy. Among these were Bartholin, Bellini, Brunner, Cowper, du Hamel, de Graaf, Gall, Glisson, Highmore, Meibom, Nuck, Peyer, Riolan, Rivinus, Ruysch, Schneider, Steno, Swammerdam, Sylvius, Tulp, Wharton, Willis, Wirsung, etc. These names are known to all physicians, and most of them still are associated with parts of the human body, but Malpighi was greater than any of these. We still associate his name not with one but

[1] Remarks at the banquet of the Italy-American Society of San Francisco at the time of the tercentenary of Malpighi.

with a number of structures in human, comparative and plant anatomy.

Anatomy was beginning to flourish. The lymphatics had recently been discovered by Aselli; rickets was about to appear in the mortality tables of England, and quinine had just been introduced into Spain. The microscope had become known in Italy four years before Malpighi's birth, and Harvey's great work appeared the same year.

Malpighi was born a few years before Leeuwenhoek, and Thomas Sydenham, Thomas Willis and Robert Boyle were born a few years before him. Kepler had died a few years before the birth of Malpighi, and the temper of Italy was as troublesome, probably more so, than that of the England of Harvey. It will be recalled that Harvey wrote in "De Motu Cordis":

> But what remains to be said upon the quantity and source of the blood which thus passes, is so novel and unheard of a character, that I not only fear injury to myself from the enmity of the few, but I tremble lest I have mankind at large for enemies, so much doth want and custom that become as another nature and doctrine when sown, and that hath struck deep root, and respect for antiquity, influence all men; Still, the die is cast, and my trust is in my love of truth, and the candor that inheres in cultivated minds.

The Italy of Malpighi's day was rather less tolerant, for its learning was at a low ebb. There was very little in the life of seventeenth century Italy to encourage, but very much to discourage a pioneer. There were beacons of learning, however, and early in his career Malpighi joined the Accademia del Cimento of Florence, an organization for the experimental study of the physical sciences, and it is to his credit that he did not hesitate to go afield and experiment in the biological sciences as well.

When Malpighi was graduated from Bologna in 1653, as doctor of medicine and of philosophy, he was fortunate in being invited to join a small group, an anatomical club (Coro Anatomico) under the leadership of his later brother-in-law, Massari, who had been recommended to him as a preceptor in medicine. This zealous group of nine dissected human bodies and experimented on animals in Massari's own home, and this experience could not have been without influence upon Malpighi's career. However, he was a born anatomist, for he experimented and practiced dissections assiduously most of his life, though through a strange irony of fate he never held a professorship in anatomy, but professorships of medicine instead. Although he served in this capacity at Bologna, Messina and Pisa, and also was greatly honored by being called to be the private physician by Pope Innocent XII, enduring renown as a physician nevertheless does not seem to have been his. This is no reflection upon Malpighi, for his chief devotion was given to other things, although his contemporary fame as a physician is amply attested by his being called to fill professorships of medicine at several universities, sometimes at truly princely salaries.

Malpighi early realized the weakness of relying upon authority in anything concerning the works of nature, and thus antagonized those who blindly followed the errors of the great men of the past. Indeed, it was his interrogation of ancient authorities that caused him to lose favor and also preferment at his alma mater, where it seems he could rightly have expected to stay after his graduation in medicine. Although he tells us that he sometimes had recourse to the "eye of reason" when the microscopes, some of which he made himself, failed him, he was impatient with the views of Hippocrates and Galen on matters of structure and function. In his work on the kidney, Malpighi wrote:

> The fact that the human mind has pondered this and similar ideas about the kidneys throughout the ages stimulated me to further investigation . . . and be sure of this one thing, that I never reached my idea of the structure of the kidney by the aid of books but by the long, patient and varied use of the microscope. . . . Indeed, some people even introduce personal opinion against the indicated course of the urine in the papillary passages. . . . Do not stop to ask whether these ideas are new or old, but more properly whether they harmonize with nature.

Although Bowman's capsule was not discovered until 1842, and Henle's loop not until 1862, that is, approximately two hundred years later, Malpighi nevertheless firmly believed that the renal glomeruli are directly connected with the ureters. Although he could not prove this by means of injections of the ureters, arteries or veins, he held that both "reason and analogy" show that the glomeruli and ureters are united. He compressed the renal papillae and saw urine escape from the collecting tubules, and also ligated the ureter and vessels upon living animals and examined these after death, in order to demonstrate the relationship which he believed must exist between them.

Malpighi's contributions to anatomy were many and permanent, as the terms Malpighian corpuscle, layer and tubule attest. His description of the anatomy of the silkworm, of the human skin, of the liver, uterus, lungs, the kidneys, the spleen and the glands marked advances in many important respects. Indeed, in regard to some of these organs little was added to Malpighi's conception until long thereafter. This was true especially regarding the liver and kidney, and the incubating egg and silkworm.

Malpighi was both keen and ingenious and studied living things not only after but also before birth. His observations on the incubating hen egg form foundation stones in modern embryology. Although he thought that parts of the mature body were preformed in the egg he made a number of discoveries and accompanied the twenty-two quarto pages of description with eighty-four very good original drawings. Since this work in embryology was done before the days of thermometers and incubators, Malpighi also may have had to impress roosters for the service of hatching the eggs after the ingenious manner described by his great countryman, "L'Omo Universale," da Vinci.

Before Malpighi's day the ideas regarding the spleen and the pancreas were decidedly fanciful. The latter was looked upon merely as a cushion to help support the stomach, and regarding the spleen it was held that so-called black bile from the liver reached the stomach by way of the spleen either through the veins or by means of a special duct passing from the spleen to the stomach. Malpighi, who had ligated the vessels of the spleen in the living, scouted these ideas, and rightly maintained that the spleen has no duct, and that no material passes from it to the stomach. He thus corrected the false old notions upon which the current phrases "too much spleen" and "suffering from the spleen" are based.

It is not without interest to recall in this connection that a text-book of anatomy written by a self-styled anatomist, for one of the largest schools of manipulation in this country—a school whose graduates were authorized by the people of our state to diagnose and treat human ills—I say it is not without interest to recall that in this text-book of anatomy it is stated that: "Chiropractors have long maintained that the spleen furnishes a secretion that is used in the process of digestion" and that the spleen "has certain relations to digestion not yet understood." Indeed, the author of this text-book of anatomy is credited with having found during our time a duct leading from the spleen to the stomach, which was named after her. It is regrettable to think that some present-day Americans are willing, when ill, to be treated upon the basis of pre-Malpighian anatomy and physiology, and blindly wave aside the knowledge gained through the arduous and fruitful labors of great men of the past such as Malpighi.

Malpighi also discovered the sebaceous glands of the skin, and showed that the papillae of the tongue are not there to keep it moist. He showed that they are associated with nerves; believed that they had to do with sensation, and drew a similar conclusion regarding the papillae of the skin.

Every one familiar with the anatomy of the skin must have been perplexed by the fact that Malpighi spoke of the deeper portion of the epidermis as rete mucosum, for both these words seem thoroughly inappropriate. In all modern dissecting rooms the sloughing superficial layer of the skin includes the entire thickness of the epidermis, which, as is well known, is so thin in most areas that one must marvel how Malpighi could possibly have distinguished a deeper from a superficial layer. Hence it does not surprise one that Bichat denied that Malpighi had seen such a deeper layer in the epidermis, for as is common knowledge, the epidermis is separated as a single layer in connection with blisters, maceration and so forth.

It seems that Malpighi included in his work on the skin a study of bovine tongues, in which when boiled or macerated, or treated with an alkali, he could detach the superficial from the deeper portion of the mucosa, which under the circumstances had become clearer, somewhat swollen and more translucent than the superficial portion of the mucosa. Moreover, since only the interpapillary portions of the deeper portion often remained after detachment of the more superficial, the former contained perforations in the places of the papillae, when it was detached, thus giving him the impression that it was a meshwork or rete. Having observed these things in the thick mucous membranes of the tongues of bovines, Malpighi by analogy seem to have transferred the conception so gained to the human skin, for the idea that skin extends up into the nostrils and mouth had then but recently been advanced.

Malpighi rightly attributed skin color to pigment located in the epidermis, although this question remained a matter of dispute for almost two hundred years later. In 1823, Beclard, predecessor of Bichat, for example, still wrote: "The anatomical texture and composition of the skin are delicate points of anatomy that have greatly exercised the patience of observers and upon which they are far from agreeing."

Malpighi showed further that the trachea ends in small air sacs in the lungs, an observation which cleared the way for a truer conception of the rôle of breathing. Since Malpighi had shown that silkworms die in spasms "in the time it takes to say a *pater noster*," if the tracheae or breathing tubules on their bodies are coated with oil, it is indeed a little puzzling why he did not himself find a closer solution for the process of respiration. However, in doing these experiments on silk worms Malpighi was circumspect and emphasized that the nature of the oil is immaterial and that the worms die even if their bodies are coated with honey.

It is particularly significant for us of to-day that

many of Malpighi's discoveries were made by the aid of experiments on living creatures and that they could not have been made in any other way. It was impossible to see the natural motion of the blood except in living beings, and it was while observing the lungs and other organs of frogs, hedgehogs and turtles, under magnification, that Malpighi discovered the existence of tubular connections between the arteries and veins which we now know as capillaries. Regarding this discovery Malpighi wrote, "I see with my own eyes a certain great thing. . . . All this you will see exceedingly well if you examine the turgid lung of a frog with a microscope of a single lens against a horizontal sun." It was in such simple words as these that Malpighi recorded the crucial discovery which was needed to bring final proof of Harvey's conception of the circulation of the blood. One can not help but surmise that Harvey would have discovered the capillaries and so completed the entire story of the circulation himself, had it occurred to him to have recourse to the microscope available at the time. However, Harvey, a relatively aged man at that time, doubted the discovery of the lymphatics and could not be expected to turn to a new method of investigation in the evening of his life.

Malpighi found that nerve fibers run from the spinal marrow to the brain, and by dissecting the boiled hearts of cattle showed that the muscle of the ventricles is arranged spirally, a discovery which was not completed till two hundred and forty-four years later, in 1900, by a young Canadian anatomist, John Bruce McCallum, working at Johns Hopkins. It is true that Malpighi did not recognize the true nature of the brain of the silkworm, and mistook the red cells of the blood for "fat globules which looked like a rosary of red coral," that he thought the spinal nerves were hollow tubes and believed the gray matter of the brain which is scattered among the white to be glandular in structure, but he nevertheless was a very acute observer, and unusually gifted in reading the great book of nature. His descriptions and drawings alone are proof of this and he carefully explained his methods.

In the light of his day, it should not seem strange that Malpighi thought that the nerves were hollow, for the existence of a "succus nervicus" was then generally accepted, and when the doctors of that time used the phrase "caput purgiis" they meant it literally, for nasal secretion—rheum—was thought to represent impurities discharged from the brain, and spinal marrow—hence such expressions as "mourning of the chine." Moreover, the ducts of several glands had recently been discovered, and these were known to be hollow, and since Malpighi thought that the entire body including the brain was glandular, the conclusion that nerves were hollow and carry nourishment seems natural enough. Malpighi further thought that the finest particles of nutriment could pass directly to the nerves from the papillae of the tongue, for he reasoned that were it not so, "Wine taken into the mouth could not restore vigor presently."

The microscope then was a new tool, and it is no wonder that Malpighi was over impressed with what it revealed. The same thing happened to Leeuwenhoek, who demonstrated testes in maggots which he found in cheese, and to Swammerdam, who demonstrated all parts of the butterfly in the body of a caterpillar. It is interesting that the conception of glandular structure for the entire body was shared also by Wharton, the discoverer of the duct of the submaxillary gland, and by the great Dutch physician Boerhaave.

In order to reveal Malpighi's breadth of scientific interest, it is only necessary to read the following list of topics selected from the many that engaged his attention:

On a pregnant mouse.

Concerning the experience of extracting salt from minerals, fossils, etc., with common water.

The structure of the aorta of bovines.

The covering of stumps of sawed-off branches with bark.

On the spoiling of ground grains by honey dew.

The old trunks of laurels.

On various parts of elephants.

The sprouting of laurel seeds.

On ears of corn spoiled by moisture and honey dew.

A hair-like fistula in the human body.

The spermatic vessels of the dormouse.

An oak gall.

The hatching of the butterfly from the pupa.

The structure of the nests of wasps.

The omentum of the mole, the medulla of the silkworm and the uterine fetus of the hedgehog.

The eye of the night owl.

The motion of the heart of the locust.

On calculi in the guinea-pig.

The vesicles and spermatic parts of castrated horses.

The white fungus of wood.

The eggs of ground snails.

The pods of castor beans.

The noctiluca.

On the tench, the locust, the butterfly and on the oesophagus and eyes of cattle and the eyes of fishes, frogs and turtles.

On bull calves, snakes and "lucertolo."

On the pregnant and non-pregnant uteri of cattle.

On the worm and cricket.

The bones of fishes and the gall bladder and gall of bovines.

On the fat of the mole.

On human skin.

The pigeon pullet in the egg.

The feces of horses and the horns of cattle.

Observations on flies, snails, guinea hens and the guinea hen pullet in the egg.

Note on tubal pregnancy.

Note on the muscles of torpedo.

The gelatin found in the cranium of "piante."

On the structure of hair, feathers and snails, bones, teeth and gout.

Observations on the ear.

The seeds of lichens, mosses and ferns.

On tides.

On the optic nerve of the swordfish and a series of other vertebrates.

Malpighi was not only an anatomist, but also a zoologist, a botanist and physiologist as well as a practicing physician. He also took interest in physics and chemistry, and was known as a chemical physician. With his wide interests went tireless industry and an indomitable spirit which was not quenched by the loss of his instruments, home and manuscripts by fire at the age of 56 but endured to the end of his active life.

It is possible that what Haeser termed his confused style and often hardly comprehensible Latin may have been a factor in the lack of a broader recognition of his many achievements in his own day and ever since then.

It stands to the undying credit of England that the Royal Society of London invited Malpighi to correspond with them, and elected him to membership. Almost all his papers written after he went to Bologna were published by that society, as Harvey's immortal work had been published in Frankfort.

Although the stirring things which happened in Malpighi's days may have spurred him on, I think that we must grant that his fruitful labors were the product of his genius and not of his day. The microscope, injections and other advances in technique were equally available to others, but no one used them to such good advantage as Malpighi. He stood at a new era, and spoke with a new voice. He was not a child of his time and his was a magic hand which illumined all it touched. His methods were objective and experimental, thoroughly modern and scientific in every way. He was an experimental, physiologic anatomist.

I have endeavored to recall very briefly some of Malpighi's services to mankind. My tribute is of necessity incomplete and inadequate, but fortunately his accomplishments speak eloquently for him. It is to these that one must turn in order to realize more fully what he did for all of us. We may not all be his friends, but all of us are his debtors.

SCIENTIFIC EVENTS

UNVEILING OF TABLET TO SIR WILLIAM AND SIR JOSEPH HOOKER

On Sunday, August 17, in connection with the meeting of the International Congress of Botanists, a tablet was unveiled at the parish church of St. Mary's, Halesworth, East Anglia, England, in memory of the famous botanist and first director of the Royal Botanic Gardens, Kew, and his equally famous son, the second director of Kew, Sir Joseph Hooker.

The tablet was unveiled by Lieutenant-Colonel Sir David Prain, a former director of Kew, and the dedication was by the bishop of St. Edmundsbury and Ipswich, who also gave an address from the text, Psalms 104, verse 24. The bishop stressed the importance of open-mindedness on the part of ecclesiastics toward the findings of science and the equal importance of a similar attitude on the part of scientists toward religious thought and work. The Scripture lesson was read by Lord Ullswater, former speaker of the House of Commons and chairman of the tablet committee. The arrangements were carried out by Professor Oliver.

The tablet was designed by Mr. A. H. Gerard, of the department of sculpture, Slade School, University College, London. The design of the lower border of the tablet is an overlapping of the corollas of certain rock garden flowers to symbolize plants growing close to the ground. The side-border design is of conventionalized flowers of a species of heath, magnified forty times, symbolizing plants that grow up into the air. At the center of the top border is represented the sun, without which plant life would not be possible, and on this border are also five conventionalized birds, symbolizing the dissemination of seeds. The design is carved in incised relief, a method used by the Egyptians some 3,000 years ago.

Medallions of the tablet will be cast by Wedgwood to supply orders received.

Sir William Hooker lived in Halesworth when a young man, and was unsuccessful in his attempt to conduct a brewery adjacent to the family home where Sir Joseph was born. When the latter was about four years of age his father abandoned business and adopted botany as a career. In this profession it was early predicted of him that he was "likely to become a person of some importance."

Among those who attended the ceremony of unveil-

ing the tablet were two sons of Sir Joseph Hooker (neither of whom went into scientific work), and the present director and assistant director of Kew.

The inscription on the tablet reads as follows:

> This tablet records the association with Halesworth of Sir William Hooker and of his son, Sir Joseph, who in succession became the directors of the Royal Botanic Gardens, Kew. Sir William Hooker lived in Halesworth from 1809 to 1820, and here Sir Joseph was born in 1817. Erected, 1930.

Those attending the exercises visited the house and room where Sir Joseph was born.

C. STUART GAGER

INTERNATIONAL SOCIETY OF EXPERIMENTAL PHONETICS

THE first Congress of the International Society of Experimental Phonetics was held at Bonn from June 10 to 15, 1930. Over 100 people attended. Addresses and demonstrations referring to all parts of the science of speech were presented.

Dr. Gutzman (Berlin) gave a striking demonstration of a Röntgen speech film in which the movements of the larynx, hyoid bone and tongue appeared with great clearness. This will shortly be combined with a speaking film so that the movements of the organs can be seen and the speech be heard at the same time. The possibilities of this method for the investigations of speech from a linguistic point of view can not be overestimated. It is also adapted to purposes of instruction, for example, of the deaf.

W. Lenk (Vienna) demonstrated a speech film apparatus suitable for laboratory use in scientific investigations. The speech may be recorded not only in the constructed form necessary for reproduction but with lengthened waves adapted to measurement. Dr. Moses (Cologne) showed that speech records vary according to the character of the person. Professor Scripture (Vienna) gave a presentation of the puff theory of the vowels. F. Janvrin (London) presented the results of an experimental analysis of a record of verse spoken by John Galsworthy himself.

Professor Isserlin (Munich) discussed aphasia; Dr. Berger (Münster) presented phonetic investigations of the Lombard Test; Dr. Kaiser (Amsterdam) showed registrations of pathologically altered voices. Dr. Hegedüs (Gödöllö) showed curves from experimental investigations on the melody of Hungary. Dr. Peters (Tartu) presented an analogous result from Esthonia.

In a paper on speech atoms and speech molecules Professor Scripture demonstrated that speech consists of a series of minute portions which for the purpose in hand can be treated as constant; these he termed "speech atoms." The combination of speech atoms into larger units such as words, sentences and so on he termed "speech molecules," according to the definition that a speech molecule is any portion of speech spoken as a unit. He showed that speech atoms influence one another when combined into molecules; the forces that act were termed "intramolecular forces." The fact that a speech atom in the latter part of a molecule can influence atoms that preceded it was considered to be a proof that each molecule was present as a whole at some time previously in the unconscious mind.

The exhibition included various oscillographs, film apparatus, graphic registration apparatus, harmonic analyzers and numerous other devices. An account of the proceedings will be published as a separate volume.

At a meeting of the council, the secretarial bureau was definitely located at 73 Welbeck Street, London, W.1, and arrangements were made to send the following publications free of charge to the members: *Zeitschrift für Experimentalphonetik*, *Bulletin of the International Society of Experimental Phonetics*, *Bulletin de la Société Internationale de Phonétique Expérimentale* and *Sprachneurologische Mitteilungen*. The membership fee was fixed at 10 shillings per annum.

Professor Hugo Pipping (Helsingfors) has been made an honorary member of the society.

THE INTERNATIONAL HORTICULTURAL CONGRESS

AT the last session of the International Horticultural Congress, on August 15, Dr. M. J. Sirks, honorable secretary, presented the report of the committee on nomenclature, whose resolutions included the following:

> A list of names valid at the time it is made should be drawn up and should be good for, say, six years. It is imperative that this list should follow strictly the rules of botanical nomenclature so far as species and botanical varieties are concerned, and that the names of plants generally accepted as conformable to the rules at the time of the making of the list should alone be used. All personal preferences and individual usage must be sunk if not in conformity with these rules. This list should be used universally in catalogues, horticultural literature, and gardens for a fixed period. An international committee should be appointed to revise this list in the light of botanical research at intervals of six years. Such alterations as are admitted at these revisions should be shown thereafter in catalogues for the next period with the superseded name as synonym.

It was added that so far as possible names of horticultural varieties should consist of a single word; the employment of not more than three words is per-

mitted as a maximum. Varietal names already in use for one variety of one kind of plant should not be used again for another variety of that kind, even though they may be attached to a different species.

The committee also decided that where personal names are used to designate varieties the prefixes, Mr., Mrs., Miss and their equivalents should be avoided; that excessively long names and words difficult to pronounce should be avoided; and that the articles "A" and "The" and their equivalents should be avoided in all languages where they do not form an integral part of the substantive—*e. g.*, Colonel, not The Colonel; Giant, not The Giant; Bride, not The Bride. Existing names in common use, it was stated, should not be altered to conform to these rules, but attention should be paid to them in all new names proposed.

It was suggested that the starting point for nomenclature of horticultural groups should be some recognized horticultural monograph; or an *ad hoc* list of varieties drawn up by a recognized body of specialists in the particular group; or, where such bodies do not exist, by some recognized society which shall be specially charged with the work.

SCIENTIFIC AND TECHNICAL SOCIETIES

ONE of the most outstanding phases of modern life is the banding together of those with a common interest and cause into associations and societies for mutual benefit. Scientific and technical men have not been slow to see the value of this pooling of interests, and the outcome has been the forming of hundreds of such societies with the general object of fostering, protecting and promoting the various professions represented.

The Handbook of Scientific and Technical Societies and Institutions of the United States and Canada has recently appeared in a second edition revised and considerably enlarged, presenting 793 societies and institutions in the United States devoted to science and its technologies, and 91 in Canada. The section for the United States was compiled by the Research Information Service of the National Research Council, and that for Canada by the National Research Council of Canada. Detailed indexes for both sections, giving the subjects covered by the societies, their research funds, publications, changes of names, etc., make the book usable from many different points of view. In the body of the publication, the secretary's name and address, number of members, times of meetings, dues, etc., give a fairly complete summary of the activities and purposes of the societies.

The purpose of the book, as stated in the preface, is "to present a ready guide to those scientific and technical societies, associations and institutions in the United States and Canada which contribute to scientific knowledge or further research through their activities, publications or funds." The tendency has been towards a broad interpretation of these requirements, several small and, perhaps from a scientific standpoint, less important societies having been included in an attempt to cover the ground as thoroughly as possible. The emphasis, in fact, is frankly on making the publication inclusive rather than exclusive.

Those who are looking for information on university or governmental organizations will not find it here. A very few outstanding bodies, such as the Smithsonian Institution, the National Advisory Committee for Aeronautics, the Scripps Institution of Oceanography, have been included as having more than the usual university or governmental interests. The general rule, however, has been to omit organizations directly under such control.

CELEBRATION BY THE MISSOURI BOTANICAL GARDEN

THE three hundredth anniversary of the first use of Cinchona will be celebrated at the Missouri Botanical Garden, St. Louis, on Friday and Saturday, October 31 and November 1, 1930.

The program opens at 10 o'clock with a trip through the conservatories, chrysanthemum show, and an exhibition of books, pictures, crude materials and drugs pertaining to Cinchona.

The address of welcome, at 11:30, will be given by Dr. George T. Moore, director of the garden. This will be followed by a symposium on the history of Cinchona; the speakers and subjects being as follows: "The Drug," by Professor Leo Suppan, St. Louis College of Pharmacy; "The Chemical," by Dr. Edward Kremers, University of Wisconsin; "The Medicinal Use," by Dr. George Dock, Pasadena, California.

At one o'clock there will be a luncheon at the garden followed by lectures at two o'clock on: "The Cinchona Industry of Java," by Dr. M. Kerbosch, director, Government Cinchona Estate and Cinchona Experimental Station, "Tjinjiroean," Pengalengan, Java; "The Pharmaceutical Preparations of Cinchona," by Dr. Wilbur L. Scoville, Detroit; "Minor Alkaloids of Cinchona Bark," by Dr. Frederic Rosengarten, Philadelphia; "The Cinchona Alkaloids in Medical Science," by Dr. Torald Sollmann, Western Reserve University, Cleveland, and "The Present Conception of the Action of Quinine in Malaria," by Dr. Kenneth F. Maxcy, University of Virginia.

The banquet, given by the trustees, to be held at

Hotel Jefferson, will be presided over by Judge George C. Hitchcock, president of the board. The speakers include Dr. A. R. Van Linge, N. V. Nederlandsche, Kininefabriek, Maarssen, Netherlands.

On Saturday visitors will go to the new Missouri Botanical Garden extension to view the orchid collections. A barbecue luncheon will follow at 1:00 P. M., after which trips will be taken to various parts of the grounds. A bus will leave for the city at 3:00, 4:00 and 5:00 P. M. A reception at the director's residence will be held in the evening from 8:00 to 10:00 o'clock.

SCIENTIFIC NOTES AND NEWS

THE honorary degree of doctor of laws from the University of Manitoba was conferred on Lord Dawson of Penn, physician to King George, and on Lord Moynihan of Leeds, at the meeting of the British Medical Association in Winnipeg.

DR. MAX PLANCK, emeritus professor of theoretical physics in the University of Berlin, has been elected president of the Kaiser Wilhelm Society for Advancing Science, Berlin, under the control of which are the various Kaiser Wilhelm Institutes.

THE Albert Medal of the Royal Society of Arts has been conferred on Professor H. E. Armstrong for his discoveries in chemistry and his services to education.

ON account of his work in behalf of rheumatic children, Dr. Frederick J. Poynton has been given the first award of the Dawson Williams Memorial Prize of the value of fifty guineas. Dr. Poynton is senior physician to the Hospital for Sick Children, London. The prize represents the interest accruing from collected funds commemorating the work of the late Sir Dawson Williams, editor of *The British Medical Journal.*

DR. E. C. KENDALL, of Rochester, Minnesota, has been elected president of the Association for the Study of Internal Secretions for the year 1930–31.

MR. K. G. MACKENZIE, consulting chemist for The Texas Company, was elected president of the American Society for Testing Materials at its recent thirty-third annual meeting, held at Atlantic City. Cloyd M. Chapman, a consulting engineer of New York, was elected vice-president. The members of the executive committee include F. H. Jackson, Zay Jeffries, H. H. Quimby, G. A. Reinhardt and H. N. Van Deusen.

DR. H. L. RUSSELL, dean of the College of Agriculture of the University of Wisconsin, who recently resigned, will become executive manager of the Alumni Research Foundation of the university.

AT the first meeting of the permanent committee of the International Union of Forest Experiment Stations, M. H. Biolley, forest inspector, of Neuchatel, Switzerland; Kammerherr von Kalitsch, of Bärenthoren, Germany, and Henry I. Baldwin, research forester, of the Brown Company, Berlin, New Hampshire, were elected associates of the union.

DR. HERBERT C. HANSON, associate professor of botany and associate botanist in the Colorado Agricultural College, has been appointed head of the college department of botany and station botanist at the North Dakota Agricultural College.

MR. H. NORRIS SHREVE, consulting chemist of New York City, has been appointed to the faculty of the school of chemical engineering of Purdue University. He will take charge of the work in organic technology.

ELEVEN new members of the Texas Technological College faculty have been chosen to replace those who are taking leaves of absence for the year 1930–31. They include Miss Mamie Klett and Paul D. Voth, biology; R. C. Goodwin, head of the department of chemistry of the University of Florida, and C. H. Connell, chemistry; H. H. Pfarr, Ohio University, business administration; Venton L. Doughtie, a graduate of Texas University, electrical engineering, and H. F. Godeke, mechanical engineering.

MR. EDWARD W. GIFFORD, formerly curator of the museum of anthropology at the University of California, has been appointed lecturer in anthropology at the University of Washington.

DR. A. F. SCHALK, head of the department of veterinary medicine and station veterinarian at the North Dakota Agricultural College, has resigned to accept the chairmanship of the newly established department of preventive veterinary medicine in the Ohio State University.

DR. J. A. CARROLL, of Sidney Sussex College, Cambridge, has been appointed to the chair of natural philosophy at the University of Aberdeen.

MR. J. ALFRED HALL, a graduate of the University of Wisconsin, has been appointed plant chemist in the Forest Products Laboratory, Madison, Wisconsin. He goes to Madison from Duke University, where he has been chief chemist of the chemical laboratory established under the Liggett and Myers Research Fellowships since 1928.

MR. PHILIP D. ADAMS, instructor in the department of agricultural and biological chemistry at Pennsylvania State College, has resigned to accept a position as research biochemist at the Skin and Cancer Hospital of Philadelphia.

DR. FRANK D. MOORE, president of the Chicago Chapter of the American College of Surgeons, has sailed for Europe to make a tour of European clinics.

PROFESSOR H. L. BOLLEY, botanist of the North Dakota Agricultural Experiment Station, has been granted a year's leave of absence for a study in South America of flax and other crops.

THE *Experiment Station Record* reports that Clyde McKee, head of the department of agronomy and vice-dean, and John A. Nelson, head of the dairy department, Montana Agricultural College, have been granted leave of absence for one year for study. In their absence A. H. Post, associate professor of agronomy and assistant agronomist, and Glenn C. Sands, instructor in dairy industry, will be acting heads of the respective departments.

DR. WAYNE J. ATWELL, professor of anatomy at the University of Buffalo, has returned from a two months' European trip during which he attended the international Anatomical Congress at Amsterdam and visited a number of anatomical laboratories.

OFFICIAL delegates of the United States to the International Congress of General Mechanics to be held at Liége from August 30 to September 7, 1930, are E. J. Rossback, Chicago, treasurer of the Association of American Engineers in France; T. A. Vander Willigen, Philadelphia, of Humphreys and Glasgow, and Millard Shaler, Portland, Oregon.

THE United States government has accepted an invitation from the French government to participate in the first International Congress on Aerial Safety, which is to be held at Paris from December 10 to 23. The American delegates will be Fayette W. Allport, commercial attaché at Paris; William L. Finger, automotive trade commissioner to Europe; Lieutenant Commander George D. Murray, assistant naval attaché at Paris; Major R. L. Walsh, assistant military attaché for air at Paris, and John J. Ide, technical assistant in Europe of the National Advisory Committee for Aeronautics.

WE learn from the *Journal* of the American Medical Association that visiting lecturers at the School of Tropical Medicine, Porto Rico, for the ensuing year will include Colonel Charles F. Craig, editor of the *American Journal of Tropical Medicine* and director of laboratories at the Army Medical School, Washington, D. C., and Dr. Theobald Smith, formerly director of the Rockefeller Institute at Princeton, N. J. Dr. Earl B. McKinley, San Juan, director of the School of Tropical Medicine, is spending the summer as visiting professor at the University of Chicago, where he is conducting a course on filtrable viruses and rickettsia diseases.

THE general subject of the Hitchcock Lectures to be given by Dr. John C. Merriam, president of the Carnegie Institution of Washington, at the University of California on September 2, 3, 8, 10 and 11, is "Nature and our Philosophy of Life." The titles of the individual lectures are: "Interpretation of Nature as Influenced by Present-day Science"; "Significance of Evolution to the Individual"; "The Poet as Interpreter of Nature"; "Educational and Spiritual Influence of Nature in its Greater Features," and "Appreciation of Nature in Day-to-day Living."

THE Seventh International Tuberculosis Congress opened at the University of Oslo on August 12. Professor Frölich delivered the opening address. There was a large attendance of French, German, Italian and Americans.

ON October 20, the Biological Club of the University of Minnesota will celebrate its three hundredth meeting. This organization is limited in membership to a small group of workers actively engaged in investigation and teaching in the broad field of the biological sciences. Meetings are held biweekly throughout the academic year, and each year some topic of general biological interest is studied, the entire year being spent on intensive study of that phase of biology. We are requested to state that past members of the organization are urged to be present at this celebration.

THE U. S. Civil Service Commission, Washington, D. C., announces the following open competitive examinations: Senior chemist, with an entrance salary of $4,600 to $5,400 a year; chemist, $3,800 to $4,600 a year, and associate chemist, $3,200 to $3,800 a year. Applications must be on file not later than October 1, 1930. The examinations are to fill vacancies in the federal classified civil service in Washington, D. C., and in field branches. Applicants may select as optional subjects any of the following: (1) Advanced inorganic chemistry; (2) industrial engineering; (3) organic chemistry; (4) physical chemistry; (5) physiological chemistry; (6) any other specialized branch of chemistry. Competitors will not be required to report for examination but will be rated on their education, training and experience, and upon published writings or a thesis.

FOR the last four summers, the departments of botany and zoology of the University of Pittsburgh have conducted classes and carried on investigations

at the State Fish Hatchery and at the biological laboratory on Presque Isle, at Erie, Pennsylvania. There has now been organized the "University of Pittsburgh Lake Laboratory," as a department of the graduate school of the university, with Dr. O. E. Jennings, head of the department of botany, as director, and with Dr. S. H. Williams, professor of zoology, as associate director. Most of the activities of the laboratory will be devoted to classes and to investigation during the summer months, but some year-round investigations, such as that of Mr. Gottschall on the phyto-plankton organisms, will also be undertaken. The varied and rich life of Presque Isle peninsula and of the adjacent bay and lake waters offers attractive opportunities for study and investigation.

We learn from *The Collecting Net* that Dr. William C. Harrington, formerly of the International Fisheries Commission, has joined the staff of the U. S. Bureau of Fisheries at Woods Hole, Massachusetts, to investigate the problem of the changes in the abundance of haddock with special reference to possible depletion.

The fertilizer department of the Anaconda Copper Mining Company has given $5,000 to the Montana Agricultural Experiment Station for a study of the value of commercial fertilizer. Mr. I. J. Nygard is in charge of research.

The State Institute of Public Health of Oslo was formally opened on August 16, Dr. Bally representing the Rockefeller Institute. The institute includes three buildings equipped with the most modern apparatus for the speedy and exhaustive treatment of illness, and with laboratories for research and for dealing with the spread of disease. The whole block of buildings cost about £195,000, of which the state contributed approximately £83,000. With a donation of £61,000 from the Rockefeller Institute, it has been possible to complete the institute. Dr. Wefring, the medical director of the institute, in his opening address referred to the gift, and warmly thanked Dr. Bally not only for the support given by the Rockefeller Institute to the Swedish Institute, but also for the aid he had personally rendered in completing the work. The Tuberculosis Congress was officially closed recently, and a great part of the members are now making a tour of the country.

By the will of Mrs. Julia Brill Patchett, of Merion, Pennsylvania, the University of Pennsylvania becomes the ultimate beneficiary of a fund of $300,000.

Organization of an administrative council for the Eastman Dental Clinic Foundation, to be established with a $1,000,000 gift made last year by Mr. George Eastman, of Rochester, has been completed and the inauguration of the foundation for active work was set provisionally for 1932. Balbino Giuliano, minister of education, presided at a meeting of the council which brought praise of the American philanthropist as a great benefactor to humanity. The council includes Professor Amedeo Perna, *president;* Dr. Ugo Frascarelli, director general of the ministry of education; Dr. Gaetano Basile, supervisor of public health; Professor Giovanni Perez, director of the institute of pathological surgery at the University of Rome; Dr. Mario Romanalli, an official of the ministry of finance, and Dr. Enrico Vallerina, of the ministry of education. Professor Aldo Foscheni, architect, is a consulting member.

Concern is felt for the future of the Royal Botanic Society because the lease of the gardens in Regent's Park expires in April, 1932. According to the London *Times,* the opinion is expressed that the society may find it impossible to continue. Mr. Henry W. Woodford, the secretary, stated recently that there was no alternative site in London and, although Mr. Lansbury, the first commissioner of works, has said that no doubt provision would be made for carrying on horticultural research work, there was no indication of the way in which it could be done.

The Alabama Polytechnic Institute and the Bureau of Standards are about to begin a cooperative research on starch at the newly opened chemical laboratories of the institute at Auburn, Ala. This investigation will have to do primarily with the starches found in crops in the South. A study will be made of the uses of starch in the manufacture of textiles, and the properties required in starch for each use. Further, it is planned to determine whether starch from one source is superior to that from another for given purposes, and if specific starches may be modified so as better to adapt them for particular uses.

DISCUSSION

CHEMICAL ACTIVATION OF QUARTZ SURFACES

It is well known that certain classes of filters operate not by straining but by selective adsorption on exposed surfaces. A yellow gasoline is readily filtered water white with fuller's earth, the yellow coloring matter and other unsaturated hydrocarbons being adsorbed in preference to the paraffins by the acid,

open-bonded silicates. Animal and vegetable oils, fats and juices containing hydroxyl groups are freed from color by charcoal or weakly basic silicates.

An adsorption filter of the silicate or hydrous oxide (Fe, Al) type normally has terminal H and OH in place and in that condition will adsorb bases for which its attraction is stronger than for these groups. Heating to about 200° C. drives off most of the H and OH as water and leaves the filter capable of adsorbing even weak free bases.[1] Certain pure quartz oil sands are known (Tensleep, Oregon Basin, Wyoming) having a thick brown adsorbed coating which can not be washed off. Oxidation with chromic acid leaves a pure white quartz crystal. The coating is about 0.7 micron thick. It will readsorb on soaking the cleaned sand over night in the heavy crude from that field.

These Tensleep quartz grains must then have been chemically activated by natural processes. What these processes are is well worth knowing from either a geological or commercial standpoint. A laboratory study soon showed that the activation of even crystalline quartz is neither difficult nor complicated. A sea sand may be given the adsorbing properties of the Tensleep very readily.

The plan was to attack the surface of the quartz with a strong alkali, forming a layer of alkali silicate over the surface, replace the base by hydrogen by means of an acid treatment, then drive off the H and OH by heating, leaving open bonds. KOH solutions would doubtless serve for the first step but are too slow. A bath of fused sodium or potassium carbonate (at 850° C.) is too violent, but fused potassium hydroxide (at 350° C.) worked very well, and did not crack even crystals of considerable size. A minute or two was sufficient time. Boiling in HCl, followed by thorough washing and drying completed the activation. The test was to soak in heavy crude over night. Fine sand and clay was tested by percolation through two inches of sand in a tube.

Since the object of the chemical treatment is to open up the SiO_2 bonds over the surface, it should be possible to dispense with the initial alkali treatment. Quartz or sea sand given a brief bath of hydrofluoric acid were found to be activated just as well as when given the alkali and HCl treatment.

It is hoped that these simple experiments may throw additional light on the still obscure mechanism of surface reactions and selective adsorption. Activated surfaces of pure quartz are excellent filters per unit area and their filtering action is pure chemical.

P. G. NUTTING

U. S. GEOLOGICAL SURVEY

[1] P. G. Nutting, *Economic Geology*, May, 1926, and November, 1928.

A CELESTIAL SEARCHLIGHT

A NARROW beam of light, suggestive of a searchlight beam, stretched across the sky from west to east, approximately through the zenith, the evening of August 21, 1930. The point of observation was 3.5 miles north of the center of Littleton, New Hampshire, and the time, 9:50 to 10:15 P. M., E. S. T. For the first 15 minutes the beam appeared brightly over the western horizon, which was 20° above a horizontal, passed through the zenith and faded in cirro-stratus clouds about 20° above the eastern horizon. During the last ten minutes the beam was distinctly south of the zenith and during the last five faded rapidly and broadened till it was scarcely noticeable. Rough angular measurements showed that the beam was about 5° wide and that it was moving southward about 10° in 10 minutes. Vega was the center of the beam about 9:57 P. M.; at the northern margin at 10:00, and from more than 5° at 10:07 to 10° from it at 10:10 P. M. There was a general auroral glow in the northern sky during this beam phenomenon, and at 10 there was a temporary appearance of an auroral streamer in the N x E. The color of the lights was the usual auroral pale greenish yellow.

A beam of the same sort was observed by the writer two or three years ago at Silver Lake, New Hampshire. It seems that these beams may be narrow auroral arches that lose their arch-like appearance and become like straight beams when overhead.

CHARLES F. BROOKS

CLARK UNIVERSITY

A SURFACE TENSION EFFECT

DURING the course of a microscopic investigation of certain oil products, great difficulty was experienced in deciding whether or not certain small spherical appearances were air bubbles. The optical behavior of these particles (diffraction rings, refractive shadows, etc.) closely resembled the appearance of air bubbles but were not quite identical. For use in direct comparison, air bubbles of about the same size were made by violent agitation of Nujol with air. A small portion of this Nujol containing bubbles ranging from 3 μ to about 5 μ was mounted under a standard cover-glass (.18 mm thick) and studied by different illuminations with a 6 mm objective and 20 × eyepiece.

While one of the smaller of these bubbles was being studied it disappeared between observations. After looking for it in some other portion of the field and not finding it, it was considered probable that its disappearance was the culmination of surface tension action. Another small bubble was picked out and carefully watched. At a diameter of about 5 μ its shrinkage became rapid enough to be measurable

with the filar micrometer from minute to minute. This rate of shrinkage increased, apparently as a parabolic function of diameter. At about 3 μ it became rapid enough to be followed by continuous observation. At about 1½ μ one side of the bubble seemed to collapse and the bubble instantly disappeared. The duration of the collapse and disappearance seemed to be from about 1/5 to 2/5 seconds. This observation was repeated again and again, starting with bubbles about 4 μ to 6 μ, and the same phenomena were always observed.

Calculation from the surface tension of the Nujol (assumed as 44 dynes) indicates that if the ordinary surface tension values hold for bubbles of this diameter (as is probably the case) the pressure within the bubbles rises to a value of about 8 pounds per square inch above atmosphere, when the bubble begins to show continuously observable shrinking, and rises to about 16 pounds above atmosphere at the time of collapse.

Believing that the resulting increase in the amount of air thus forced into solution should be reflected in the behavior of larger bubbles, the diameters of the larger bubbles were carefully observed with the filar micrometer, and they did, in fact, show growth, although it was so slight that it would not have been noticed without careful measurement. The effect has not been studied either with other gases or with other liquids such as aqueous solutions, but there seems to be little reason to expect any differences except those of degree.

The primary purpose of the experiment was excellently served. In the microscopic preparation being studied, the rounded particles suspected of being air bubbles varied from about ½ μ to about 5 μ and the various sizes frequently occurred in close proximity to one another. It was, therefore, possible to say positively that the rounded particles could not possibly have been air bubbles because the experiment proved that bubbles less than about 3 μ diameter could not be stable in such liquids. The larger bubbles grow and the smaller vanish by loss of gas to the liquid and thence to larger bubbles or to any exposed surface.

So far as known, this effect has not been previously observed and recorded. Once considered, however, it should obviously be expected, although a number of scientists to whom it was mentioned have at first doubted its possibility. Attention is called to it because it may provide a method for studying the degree to which normal surface tension laws continue to hold true for highly curved surfaces and also because this effect explains many phenomena not hitherto made wholly clear. It sheds light on the ready clarification of sirups, lacquers and other highly viscous solutions in which minute bubbles could not be expected to reach the surface in any reasonable length of time. It indicates a contributory factor in mineral froth flotation by mechanical agitation. It serves to explain the ease with which liquids may be highly supersaturated with gases and certain apparently anomalous phenomena observed in the absorption of gases in towers, tanks, tourilles, etc. It gives a clearer understanding of the sudden and violent "bumping" of superheated liquids.

It may even be found to have a physiological bearing on the condition of dissolved gases in the blood stream, and the consequences of marked changes in pressure, as in aviation.

WM. M. GROSVENOR

COLLEGE TRAINING FOR THE FISHERIES

ALL successful men have an education. Some get it without going to school and some get it after going to school. Yet the college education may be a very helpful step-ladder to success. As to the kinds of trained required for success in the fisheries field there is much confusion of thought. This is due to the lack of a proper analysis of the various branches of the fisheries into which one may embark. The biologist thinks largely in terms of biology, the technologist in terms of chemistry, physics and engineering, and so on ad hominem. Few have really analyzed the fisheries field in its entirety, breaking it down into fundamental lines of equal rank but quite different in the character of training required. This discussion is written with the hope of clarifying the situation and aiding students to map out educational courses with definite objectives in view after graduation.

Before actually outlining these fields, first let us break down the prospective personnel into three groups of persons: (1) Those bent on becoming highly trained key men in their respective fields; (2) those of good education or wide experience upon whom the first group must largely depend for the carrying through of their particular program; (3) those with limited capabilities for advancement either through lack of training or for other reasons.

In this age of specialization the key men must be highly trained, each in a particular field. What are these specialized fisheries fields and what classes of positions are open? These are four in number—fisheries biology, economics, technology and administration. Having selected one of these fields, the prospective fishery expert will not dissipate his efforts on various courses in any of the other three fields, but will center his undergraduate studies on one par-

ticular field. He will of course select that group of subjects which he will most need later on. Upon graduation he will be well trained in that field, be it administration or biology or economics or technology. By so doing he should be equipped to seek positions in the fisheries or other fields requiring a high degree of training in biology or technology or economics. This is basic training, the lack of which so often has greatly restricted the graduate from achieving the success to which he aspired and clouded the apparent usefulness of the institution of learning. Our student is now either a biologist, an economist or a technologist or prepared to enter the field of commerce and administration. He certainly is not a jack-of-all-trades, lacking specialized training in any field. If unable to take post-graduate work he is prepared to give a good account of himself in his chosen field.

If in his undergraduate days our student planned to enter the fishery field, he will have chosen his undergraduate studies with that end in view and after graduation, if practical, he will major in his chosen field, conducting independent research which will give him practical training and demonstrate his capabilities as a research worker.

BIOLOGY

If our student chooses fisheries biology, he should select courses fitting him for specialization in one of a number of fields such as aquiculture (including fish culture), fisheries science, oceanography, pollution, physiology or some other such field. He will have taken fundamental courses in biology, physiology, etc., and special courses to qualify him for his particular field. For example, if he proposes to specialize in fisheries science he will not neglect his mathematics and statistical practices. There should be open to him on completion of his studies biological positions in federal and state governments, in private employ, etc. There are over four hundred federal and state hatcheries, and the number is growing. In time each of these should be headed by men with a good grounding in biology. The day is at hand when the water farmer—oyster, goldfish, trout, terrapin, clam—will need a biologist to help raise his standard of production and overcome the many difficulties encountered. These are but a few of the many possibilities.

ECONOMICS

In case our student specializes in fishery economics, he has open to him federal and state positions. In my opinion, the man who made the greatest contribution to fisheries science in 1929 was an economist who unfortunately will receive very little personal credit for the culmination of some five years of specialization. I refer to the chief fishery investigator of the U. S. Tariff Commission, who probably has no superior in fishery economics in the country. There are various other positions in this group in the more specialized fields of fishery statistics, marketing, world trade, etc. Not only that but large business enterprises are rapidly taking on economists to help them meet successfully the very keen competition for world markets. The principal reason for there being so few in the fisheries field is the lack of trained fishery economists capable of demonstrating their value to industry.

TECHNOLOGY

Here as in the biological field our student would do well to determine what particular branch of fisheries technology he expects to follow. He may specialize in chemistry, engineering, canning, etc. The first fishery products laboratory in this country was established in Washington, D. C., in 1918, and the first college of fisheries at the University of Washington, Seattle, in the same year. These institutions have contributed greatly in making the fisheries technologically minded, as well as serving as training schools for graduating into industry men who have assumed positions of leadership in their professions. The rapidity with which well-trained men have been snapped up demonstrates adequately the need for training additional men for this field, which holds forth opportunities for financial reward as great as any in the fisheries field except possibly the following group.

ADMINISTRATORS

As in other lines of administration and commerce, there is room for highly trained executives in the fisheries field. In industry these men can well follow the usual business courses, including business organization—business law, marketing, principles of advertising, exporting, importing, employment, organization and management, statistics, credits and collections, salesmanship, sales management, etc.; geography—world trade, industries, trade centers, trade routes, geography and history of commerce, etc.; economics, cost accounting, etc. This group is more closely affiliated with economics than with either of the other groups.

In addition to the business executives, there should be many openings in state governments. Our heads of departments of conservation should be taken out of politics and replaced by capable and well-trained administrators with a full appreciation of the importance of biology, economics and law enforcement procedure.

At the beginning of this acticle, I divided our fishery personnel into three groups. In succeeding pages, I have discussed primarily the training required by the key men. Those of good education who fall short of finding a place in the first group will automatically gravitate to the second. What I have attempted to emphasize is the need for specialized training and the avoidance of taking a hodgepodge series of subjects in biology, technology, economics, navigation and snap courses which give credits toward graduation but may lead to the dismal swamp of failure after graduation. Perhaps that is a bit overdrawn, for any training in the fishery field promises to be better than no training at all. In fact, the science of agriculture has passed through various transition stages to its high state of perfection of to-day reflected in the names of many of the bureaus in the U. S. Department of Agriculture, *viz.*, Bureaus of Agricultural Economics, Animal Industry, Dairy Industry, Plant Industry, Chemistry and Soils, Entomology, Home Economics, etc. Of the four fisheries fields referred to, there is the greatest need to-day for trained men in economics and administration, men who will demonstrate the importance of such training to the industry.

Any university desiring to give special attention to training men for the fisheries and already having strong departments of biology, economics, technology and administration should have a well-trained economist and administrator familiar with the fisheries and the opportunities which the fisheries field has to offer as a head of the fisheries group. During the four years of undergraduate work, students intending to specialize in fisheries, in whatever field, might be given a one-hour weekly lecture course by this man to bring them together as a unit and familiarize them with the fisheries field. Lecture courses would include domestic fisheries, world fisheries, importance of fisheries and fishery products, methods of preservation and utilization, costs of production (rudimentary), competitive situation, exports and imports and other basic training needed for a proper understanding of the fishery situation. Under this plan the fishery head could carry the principal burden of training and directing fisheries men into proper fields. Such a plan would not require an extensive fishery organization but would have the advantage of training men for all branches of the fisheries. There is no adequate plan of this character in existence in the United States to-day.

LEWIS RADCLIFFE,
Deputy Commissioner of Fisheries
BUREAU OF FISHERIES

SUPPORT OF THE ZOOLOGICAL RECORD

VOLUME 66 of the *Zoological Record* contains the announcement that "Volume 67, dealing with the literature of 1930, is in preparation and will be printed and published if a sufficient support is obtained." The *Zoological Record* is accepted in this country too much as a matter of course. Not enough thought is given to the great amount of work required to prepare it, the contribution of the Imperial Institute of Entomology, nor to the financial burden of publishing it largely borne by the Zoological Society of London.

The *Zoological Record* is a necessity wherever taxonomic work is done, but it has never received due support from American institutions, where now in the aggregate it must be put to more use than in any other country in the world. American institutions should realize that subscriptions (in our sense) do not support the *Record;* in fact they do not bring back a fourth of the outlay on each volume. The remainder of the cost must be made up by contributions, and the Zoological Society of London should not be expected to carry the whole load. For Volume 65 the contribution of that society exceeded five times those from all other sources combined.

The situation is manifestly unfair, as the work is an altruistic one serving the needs of systematists everywhere. There is no substitute for the *Zoological Record,* and if its publication were suspended, American institutions would find it necessary at once to produce such a publication themselves. This can be avoided by giving merited support to the present going publication. Every American museum and every American society or institution having workers doing systematic work should feel under obligation to contribute to the *Zoological Record.* Directors of museums and treasurers of societies should put an item for this purpose in their annual budgets so that it shall not be left to chance, or perhaps come up for consideration when no funds are available. Contributions should be sent to the Secretary, Zoological Society of London, Regent's Park, London, N. W. 8, England.

The report of the society for 1929 contains a statement on contributions to the *Record* and it is not one to make an American feel proud. A few individuals and societies have done nobly, but museums in general have simply shirked. There is an obligation for support upon those who use the *Zoological Record,* and it is to be hoped it will be taken much more seriously by American institutions in the future than it has been in the past.

W. L. MCATEE
WASHINGTON, D. C.

QUOTATIONS

A GREAT ASTRONOMER

PROFESSOR TURNER, whose death at the age of sixty-nine is announced on another page, was not only a pioneer in astronomical research, but was also a singularly gifted expositor of the wonders of his science. In him *The Times* loses a valued contributor of long standing.

Herbert Hall Turner, the son of Mr. John Turner, was born at Leeds in 1861, and was educated at Leeds Modern School, Clifton College, and Trinity College, Cambridge. His career at Cambridge was brilliant; he graduated as second wrangler in 1882, and was second Smith's prizeman in the following year. He was elected a fellow of Trinity, but left Cambridge in 1884 to become chief assistant at the Royal Observatory, Greenwich, where he remained until 1893, when he was appointed to succeed Professor Pritchard as Savilian Professor of Astronomy and director of the University Observatory at Oxford.

Turner's contributions to astronomy were remarkable for their number and variety; he published over two hundred papers and essays on scientific subjects. He had a fertile and ingenious mind, and more than the usual amount of courage in putting forward ideas and speculations. Many of his ideas have not met with general acceptance, but this is a fate that must befall some part of the work of any one who has a claim to be called a pioneer. When he assumed the direction of the University Observatory at Oxford, he found it committed to taking a part in the international scheme of mapping the heavens, which had been decided upon at a conference in Paris in 1887, and he threw himself into the work with so much enthusiasm that the Oxford section was finished before that of any other observatory, with the exception of Greenwich, the only other observatory in England which was allotted a part in the scheme. He then proceeded to help some of the other observatories which were finding the burden of the work too heavy for them, and when the International Astronomical Union was formed after the war, he was elected president of the committee delegated to deal with the scheme.

Much of the technique of the methods now universally employed for deriving the positions of stars from photographs is due to him, and this is perhaps his greatest contribution to astronomy. He also did a large amount of useful work on the classification of variable stars, and put forward a theory to explain stationary meteor radiants, but his explanation of sunspots as being due to a swarm of meteors formed by collision between the Leonids and the rings of Saturn has not been generally accepted, and the same must be said of his attempt to account for the two star streams in terms of gravitation.

When Professor Milne, the seismologist, died in 1913, Professor Turner took over the control of his seismological bureau at Shide, and on the return a few years later of Mrs. Milne to Japan the bureau was moved to Oxford, where it remained under the direction of Professor Turner as president of the seismological committee of the British Association. He was also president of the seismological section of the International Geophysical Union, and himself did a large amount of work on the analysis of earthquake records, with a view to detecting periodicities in them. His frequent communications to *The Times* on earthquakes he had detected in remote parts of the world will be well remembered, as also his letters and articles on eclipses and other astronomical subjects.

He spared no effort to promote international cooperation in astronomy, and was a well known and popular figure at international conferences, of which he attended a large number. He also went on several eclipse expeditions, including those to Japan in 1896 and to Egypt in 1905, and when the office of foreign secretary of the Royal Astronomical Society fell vacant in 1919, he was clearly marked out for it.

Turner had a great gift for presenting the complicated facts of modern astronomy in a way easily understood by the lay mind, and was an excellent lecturer. He wrote four very readable popular books on astronomy, "Modern Astronomy," "Astronomical Discovery," "The Great Star Map" and "A Voyage in Space," the last being the outcome of a series of children's lectures at the Royal Institution in 1913. For more than thirty years he contributed each month to the periodical, the *Observatory*, a series of notes, light in vein, under the heading "From an Oxford Note Book," which formed a feature of the magazine that has been greatly appreciated by astronomers all over the world. He was for many years secretary, and then president, of the Royal Astronomical Society Club, where he could always be counted upon for an apt after-dinner speech, and, on occasions of any importance, for a song. He had the all too rare gift of being able to enter into other people's difficulties, and there must be many amateur astronomers, in addition to some of the younger professional astronomers, who will always gratefully remember help and advice given both frequently and ungrudgingly.

As Savilian Professor at Oxford, Turner became a fellow of New College. Coming to the university, he

threw himself wholeheartedly into the intimate life of the college, entering with zest into its activities, educational, scientific and social, and contributing a valuable element to its discussions by his independent, yet sympathetic, point of view and a breezy disregard of conventions which now and again shocked more conservative minds.

It was unfortunate that the refusal of the university to provide an official house in the Parks for the Professor of Astronomy made his relations with the university less cordial. This and the remoteness of astronomical studies from the ordinary curriculum rendered his influence in Oxford less than it ought to have been. But those who knew him well were aware of the keen interest which he took in its studies and general welfare, and also in the lives of his friends and colleagues. No one was more ready to give active help to his friends in any time of trouble. It was characteristic of his generous temper and his sympathy with struggling causes that from the first he gave his vigorous support to the Workers' Educational Association and the organization of tutorial classes. In this work his optimism and persistence were invaluable.

Here, as in everything else he took up, his help was direct and personal. He had the courage and strong will of a true Yorkshireman, and he also shared the North Country love of music; he was an assiduous member of the Oxford Bach Choir, and an active supporter of musical enterprises. A lover of the open air, he had a close acquaintance, by bicycling, boating and walking, with the beautiful country near Oxford, and in other parts of England, and his scientific expeditions gave him a wide acquaintance with the oversea dominions and with foreign countries. In these activities he was fortunate in having a wife who shared in his tastes and in much of his travel. The astronomical world is weaker by his death, and he has certainly left in his college and among his friends in the university a place which can not be filled.

Professor Turner was elected a fellow of the Royal Society in 1896, and was president of the Royal Astronomical Society in 1903 and 1904. From 1913 to 1922 he was one of the general secretaries of the British Association. He was given the honorary degree of D.Sc. by the Universities of Leeds, Sydney, Wales and Strasbourg, that of D.C.L. by Durham, and that of LL.D. by California. He was also a corresponding member of the French Institute, and he received the Bruce gold medal of the Astronomical Society of the Pacific in 1927.—*The London Times.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN IMPROVED METHOD FOR THE STUDY OF NUTRITIONAL ANEMIA IN THE WHITE RAT

RAPID progress in solving the mysteries surrounding the underlying causes of pernicious anemia has been made within the past four years.[1] One of the phases of this problem which has attracted the attention of many investigators is the study of nutritional anemia in the white rat.

Young rats at the weaning age become anemic when fed 4 to 6 weeks on whole milk only, for at this stage the store of iron in the body is at a low ebb. It has been noted in some instances, however, that anemia did not appear unless milk was fed over a prolonged period or even to the second generation.[2] The authors were surprised to find that under the conditions in their laboratory a number of rats fed whole milk only or whole milk plus cod-liver oil grew well and for the most part were about normal in hemoglobin content (Fig. 1). Studies were therefore conducted to learn why the conditions under which these animals were kept were not conducive to anemia.

[1] SCIENCE, 71, (No. 1850): x, June 13, 1930.

[2] W. M. Happ, *Bul. Johns Hopkins Hosp.*, 33: 163, 1922.

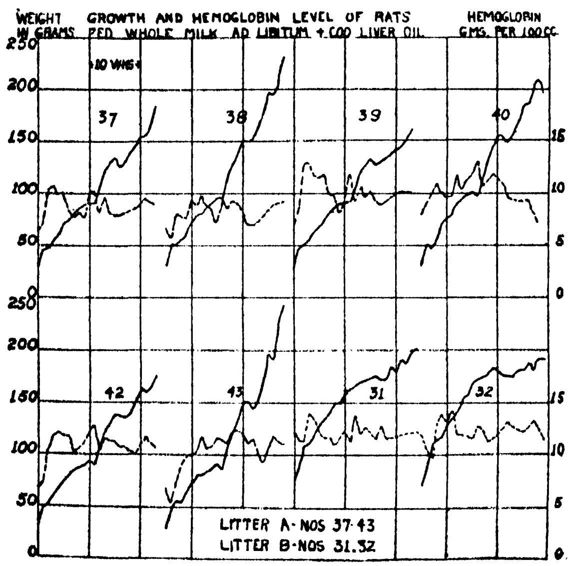

FIG. 1. Contrary to expectations, young rats fed whole milk and cod-liver oil made good growth and in most cases were normal in hemoglobin content. The solid curves show live weight and the broken lines the amounts of hemoglobin in the blood.

The cages employed in the early work were constructed of galvanized iron wire, having a mesh small

enough to retain most of the feces. There were places on the cages where the zinc had been worn off. The rats were observed to gnaw these wires vigorously.

Questions were therefore raised regarding the effect upon hemoglobin formation of several factors, including the material of which the cage was composed, the access of the rat to fecal material, the feeding of cod-liver oil, and others.

Cages of different material were therefore constructed. In these the wires or rods forming the bottoms were spaced one half inch or more apart to prevent retention of feces in the cage. Later all cages were equipped with legs to prevent the animals from reaching shavings or feces below the cages. Paired feeding trials carried out with animals kept in cages of different materials showed that the low hemoglobin values of young rats at the weaning stage rose quickly to normal when the animals were placed in iron wire cages and remained at high levels (Fig. 2). The animals in glass, copper and well-galvanized iron wire cages gradually became anemic. Some cures of anemic rats have been effected by placing them in a cage of common iron wire.

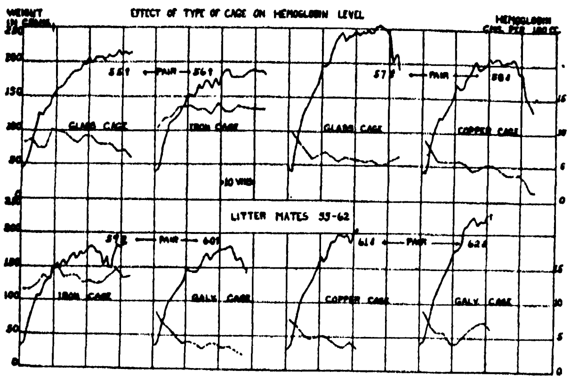

FIG. 2. Rats can secure enough minerals from cages in which iron wire is exposed to prevent anemia.

With the evidence at hand that the material used in construction of the cages may have a pronounced effect upon the condition of rats kept in them, other factors were studied, using cages in which the animals could come in contact with nothing but glass.

Cod-liver oil was found to have no effect, the hemoglobin values of young animals fed fresh whole milk and cod-liver oil declining rapidly. This result has also been noted by Krauss.[3]

The literature is lacking in detailed reports of the feeding methods used in different laboratories. Apparently animals are fed once daily in some cases, twice daily in others and in one instance once daily six days per week. The effect upon hemoglobin titer of the amounts of milk consumed was studied (Fig. 3). Lot 1 was fed milk once daily six days per week.

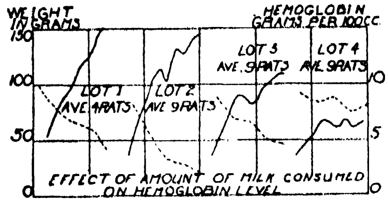

FIG. 3. Consumption of large amounts of milk induces anemia more quickly than small amounts.

Growth was rapid and hemoglobin values declined less rapidly than in Lot 2, which was fed milk ad libitum twice daily seven days per week. Lots 3 and 4 were fed in the same manner as Lot 2, except that they received only three fourths and one half, respectively, the amount consumed by Lot 2.

Carefully controlled paired feeding trials in which the control animal was fed milk twice daily ad libitum, and its mate three fourths the amount, also showed that the hemoglobin values in the animals fed the smaller amount declined less rapidly.

As already noted, the galvanized wire cages used in the first trials had a mesh of such size that many of the feces were retained in the cages. The effect of the presence of feces in the cages was studied in paired feeding trials in which the animals were kept in specially constructed glass cages. The bottom of the cage for the control animal consisted of glass rods spaced about one half inch apart, while in the cage of the pair mate the glass rods were close enough together to retain the feces. The hemoglobin values of all animals declined rapidly, but those of the animals having access to feces declined somewhat less rapidly (Fig. 4). A more efficient utilization of food by rats having access to excreta and shavings was noted by Griffith.[4]

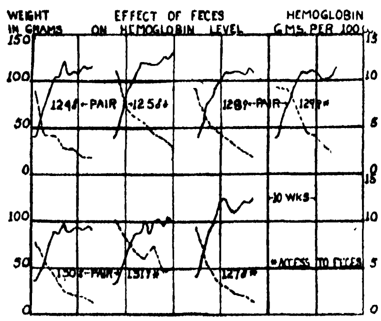

FIG. 4. Access to excreta delays somewhat the progress of anemia.

In view of these findings, a special laboratory technique for the study of nutritional anemia has been developed.

The cages are constructed of wood and glass in such a way that the animals can come in contact with noth-

[3] W. E. Krauss, *Jour. Dairy Sci.*, 12: 438, 1929.

[4] W. H. Griffith, *Jour. Biol. Chem.*, 85: 751, 1930.

ing but glass. Tops and bottoms consist of glass rods spaced about one half inch apart. The top is removable. Sides are lined with window glass. The floor space allowed each animal is about 10 x 14 inches. Cages are mounted on legs about 4 inches high. Galvanized iron pans 2 inches deep and containing wood

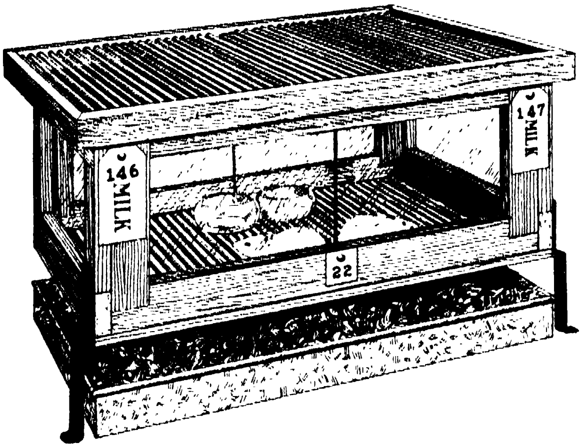

Fig. 5. Two-compartment glass cage designed for the study of nutritional anemia.

shavings fit loosely below the cages to receive the excreta. Shavings are changed twice weekly. Cages are washed once weekly, a washing powder solution being used, followed by rinsing with tap water, then distilled water, and drying with a clean towel.

Glass sponge dishes (common office type) are used as feed dishes. These are practically non-spillable, easily washed and not readily broken. These are washed twice daily, using a stiff brush with washing powder solution. They are rinsed in tap water, drained on a drying rack made of glass rods, then rinsed in water redistilled from glass, and again drained.

The whole milk used is obtained by milking the cow directly into a glass funnel and glass jug. It is placed in a refrigerator shortly after milking. A fresh supply is obtained daily.

Hemoglobin determinations are made every two weeks, using a colorimeter with Newcomer hemoglobin attachment. This is checked for accuracy by means of the Van Slyke oxygen capacity method.

The plan of feeding animals in pairs is employed in most cases. In this plan two litter mates of the same sex and weight constitute a pair. Milk is fed twice daily, the amounts fed being adjusted so that the amounts eaten by both animals are the same. The specially treated milk or special experimental routine is given one animal, the other constituting a control or check animal. Differences in food intake, which often greatly complicate the interpretation of results, are thus avoided. It is possible in this way to attribute differences in growth and hemoglobin levels to the experimental condition under investigation.

Summary and Conclusions

Experiments in our laboratory have demonstrated that white rats fed only fresh whole milk secured enough minerals from their cages to prevent anemia.

Animals consuming large amounts of milk became anemic more quickly than those limited to small amounts.

Access to feces delayed somewhat the onset of anemia.

These results probably explain some of the conflicting data reported in the literature and also raise a question regarding the correctness of conclusions drawn from experiments in which recognition was not given the factors shown in this study to be important.

W. B. Nevens
D. D. Shaw
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SOME NEW METHODS AND COMBINATIONS IN PLANT MICROTECHNIQUE

It is a common experience to find beginning students in plant histology failing to secure good sections of ordinary or thin leaves embedded in paraffin, because of serious plasmolysis or imperfect infiltration.

It occurred to the writer that the glycerine process used in the Venetian turpentine method for extremely delicate tissues such as algae might be adapted to the paraffin method to assure dehydration without plasmolysis. This year, the following method has been tried with excellent results even by students that are below average.

In the case of leaves that have been killed in an aqueous solution, the material is first thoroughly washed, then put into 10 pts. glycerine + 90 pts. water, in a flat open dish, and left until the solution becomes about as thick as pure glycerine. It is then washed in 95 ethyl alcohol and put through two changes of absolute ethyl alcohol, followed by: absolute alcohol 3 pts. xylol 1 pt.; absolute alcohol 1 pt. xylol 1 pt.; absolute alcohol 1 pt. xylol 2 pts.; pure xylol. It is then embedded in paraffin in the usual way.

Leaves that have been killed in an alcoholic solution, however, after being washed in a similar concentration of alcohol, are put into a solution of glycerine mixed with a water percentage equal to the alcohol percentage of the killing solution. For instance, material killed in a 50 alcohol-acetic acid-formalin solution is first put into equal parts of glycerine and water. With this exception, the method is the same as that used following an aqueous killing solution.

In every case, leaf material prepared in this way is less brittle and cuts much more easily than after the usual treatment (perhaps because it is in alcohol a shorter time), and even when embedded by more or less careless students shows little or no plasmolysis. This method also requires less attention.

The following modification of the method for "dehydrating woody tissue for paraffin embedding" as given in SCIENCE for January 24, 1930, has been used successfully.

After the killing and fixing solution has been washed out, if the material is soft enough to cut easily, it is placed in 10 pts. glycerine + 90 pts. water and left until the water has evaporated. It is then put into equal parts glycerine and butyl alcohol for about 36 hours, followed by pure butyl alcohol for another 36 hours. It is then embedded as described in the article in SCIENCE. Three to six days in the paraffin bath may be necessary to secure thorough embedding.

If tissues are part hard and part soft, they may be softened in C.P. hydrofluoric acid + 95 alcohol, as this method, according to Dr. E. C. Jeffrey, injures delicate tissues less than hydrofluoric acid diluted with water. If tissues are very hard, they may be put into C.P. hydrofluoric acid for three or four weeks, then washed and treated as described.

This method has the advantage of practically avoiding the use of ethyl alcohol, with the result that the material is less brittle and no harder than before dehydration. The longer time in the paraffin bath does not appear to make woody tissues hard and brittle. This method likewise requires less attention.

In dry weather or in dry climates it has been found that the addition of eight or ten parts of glycerine to preservatives such as alcohol-acetic acid-formalin is efficacious in preventing rapid evaporation caused by imperfect cork stoppers.

In cutting wood sections that are likely to curl, if the microtome knife is kept wet with equal parts of glycerine and 95 alcohol, and each section is permitted to remain on the blade a few seconds after cutting and is then transferred to a dish of the same solution, this difficulty is entirely avoided.

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SPECIAL ARTICLES

DATA ON A PROTEIN-ANTIBODY SYSTEM

It was recently shown by the writers that the entire course of the precipitin reaction between Type III pneumococcus specific polysaccharide and purified homologous antibody could be expressed quantitatively by simple equations that follow the mass law.[1] Since it was of interest to determine whether a similar method of treatment might be applied to a true antigen-antibody system, recourse was had to the compound azo proteins, so fruitfully employed in the solution of other immunochemical problems by Landsteiner and by Avery and Goebel. It was felt that if a protein dye could be synthesized of more intense color and more rigorously freed from its component substances than those used by these workers, a possible means would be at hand for distinguishing between antigen and antibody nitrogen both in the precipitates and supernatants, since the antigen could be determined colorimetrically. A purplish-red disazo protein dye, *R-salt-azo-benzidine-azo-egg albumin*, was finally isolated in a form which satisfied these requirements, the more so as the antibody solutions obtained by sodium sulfate fractionation of rabbit antisera to the dye were substantially colorless.

By methods analogous to those used in the first paper[1] it was found that at the lowest concentration of dye protein used, 1:67000, the mean ratio between antigen and antibody precipitated was 1:15 (8 determinations); at the equilibrium point,[1] at which the proportions of the reactants were such that both antigen and antibody were present in solution, 1:7.5 (6 determinations), and in the inhibition zone, after the maximum precipitate was reached, 1:3 (14 determinations).

These preliminary data indicate that the composition of the solid phases formed by the precipitin reaction between the dye and its antibody may be expressed by the three limiting equations:

$$\mathrm{An} + \mathrm{Ab} \rightleftarrows \underline{\mathrm{AnAb}},$$
$$\underline{\mathrm{AnAb}} + \mathrm{An} \rightleftarrows \underline{\mathrm{An_2Ab}}, \text{ and}$$
$$\underline{\mathrm{An_2Ab}} + 3\mathrm{An} \rightleftarrows \underline{\mathrm{An_5Ab}},$$

in which An = antigen and Ab = antibody. The data so far obtained are insufficient for a decision as to whether the soluble compound formed in the inhibition zone is $\mathrm{An_6Ab}$ or $\mathrm{An_7Ab}$. Further work is in progress and a detailed report will be made when this has been carried out.

Whether or not modification of the above ratios be necessary, it would appear that the precipitin reaction between a true antigen and its antibody is essentially the same as the precipitin reaction in a hapten-antibody system or, for that matter, essentially the same as a typical inorganic precipitation reaction, and may

[1] *Jour. Exp. Med.*, 50: 809, 1929.

be quantitatively expressed by suitable application of the laws of classical chemistry.[2]

MICHAEL HEIDELBERGER
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THE AMOUNT OF CIRCULATING PRECIPITIN FOLLOWING THE INJECTION OF A SOLUBLE ANTIGEN

IN the preceding note preliminary data were reported on the precipitin reaction between a protein and its homologous antibody. These data permit for the first time a calculation of some theoretical interest; namely, the amount (weight as opposed to titer) of circulating precipitin in an animal following immunization by a given amount of antigen. For example, rabbits 49 and 54 were injected with small doses of *R-salt-azo-benzidine-azo-egg albumin* until a total of 21.6 mg of the dye had been given. The animals were bled 10 days after the last injection, and antibody solutions were prepared by sodium sulfate fractionation and made up to double the serum volume. This may be considered as blood volume for the present purpose. The maximum specifically precipitable protein[1] in solution 49 was 1.53 mg per cc; in solution 54, 1.25 mg per cc. Taking the weight of the rabbits as 2 kg and their blood volume as 5.5 per cent. of their weight,[2] or 110 cc, the blood of rabbit 49 contained 168 mg of precipitin at the time of bleeding, while that of rabbit 54 contained 138 mg. Calculated as milligrams of circulating precipitin per milligram of antigen injected, the values are 7.8 and 6.4, respectively.

Naturally these figures are inaccurate, since the exact blood volumes of the rabbits were not known. From the theoretical standpoint, however, it is of interest that they are probably low, since losses undoubtedly occurred in the preparation of the antibody solutions. Moreover, these values can only represent a fraction of the total antibody formed, since storage in the cells occurs as a result of sensitization of tissues and organs. It is also not certain that the circulating precipitin is the only circulating antibody. On the other hand it is considered, as in the preceding studies, that antibody is modified globulin, and that the antibody precipitated is not contaminated with non-specific serum globulins. Evidence on the latter point will be reported later.

According to Svedberg and Sjögren[3] the molecular weight of serum globulin is three times that of egg albumin. If one assumes antibodies to have about the same molecular weight as the globulins with which they are associated, and the egg albumin dye to have about the same molecular weight as egg albumin, each dye molecule would have to split into more than two specifically reactive fragments if it participated in the building up of the antibody molecule. However, Landsteiner has repeatedly shown that the specificity of the azo protein dyes is a function of the dye component, rather than of the protein used. It would therefore be reasonable to expect that if the antigen or any of its fragments participated in the building up of the antibody molecule the antibody would be colored. It is true that the crude antibody solutions obtained by fractionation of the sera of animals immunized to the red protein dye were definitely pink, but the color disappeared almost completely on dialysis.

The preliminary data herein presented therefore tend to favor the view that the antigen itself does not participate in the building up of the antibody complex. Further information on this and related questions is being sought along these lines and it is hoped that more decisive figures will be obtained.[4]

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[2] This study was carried out under the Harkness Research Fund of the Presbyterian Hospital.

[1] *Jour. Exp. Med.*, 50: 809, 1929.

[2] Meek and Gasser, *Am. Jour. Physiol.*, 47: 302, 1918–19.

[3] *Journ. Am. Chem. Soc.*, 50: 3318, 1928; 52: 2855, 1930.

[4] This study was carried out under the Harkness Research Fund of the Presbyterian Hospital.

CORRELATION OF ANTILLEAN FOSSIL FLORAS

CERTAIN Antillean plant beds have been described by Drs. Hollick,[1] Vaughan and Berry,[2] Hodge,[3] Howe[4] and Maury,[5] and a tentative grouping and correlation is now suggested.

The Nilssonia bed, Porto Rico.—South of Cidra, Mr. Hodge found plants in a bog iron ore bed.

[1] "Rio Collazo Plant Beds, Porto Rico," "Scientific Survey of Porto Rico and the Virgin Islands," Vol. 7, pt. 3, 1928; "Siparia Flora, Trinidad," *Bull. N. Y. Bot. Garden*, vol. 12, No. 45, 1924; "Rio Guajataca Flora, Porto Rico," *Jour. N. Y. Bot. Garden*, 27: 223–7, 1926.

[2] "Sánchez Flora, Dominican Republic," "Geological Reconnaissance of the Dominican Republic," p. 165, 1921.

[3] "Algae of Coamo Springs Limestone, Porto Rico," "Scientific Survey of Porto Rico," vol. 1, pt. 2, pp. 153–9, figs. 15, 16 (not 18), pp. 195, 228, 1920.

[4] "Algal Flora, St. Bartholomew, Antigua, Anguilla," Carneg. Inst. Wash., Pub. No. 291, pp. 11–19, 6 plates, 1919.

[5] "Los Quemados Flora, Dominican Republic," *Bull. Amer. Paleontology*, No. 30, p. 19, 1917.

These were identified by Drs. Berry and Knowlton as *Nilssonia,* an old Mesozoic cycad genus; a species of the fern *Protorhipis,* and a dicotyledon. Drs. Britton and Hollick, in 1926, 1927 and 1928, examined this locality but found only unidentifiable plant fragments.

The *Nilssonia* flora lay beneath a horizon with corals referred by Mr. Hodge to *Cladophyllia furcifera,* suggesting an age corresponding to the Fredericksburg group of the Lower Cretaceous of the gulf states. But the foraminiferal evidence of the Rio de la Plata series said to underlie the Baranquitas-Cayey series (of which the *Nilssonia* bed is a member), as identified by Dr. Bagg, suggests an Upper Cretaceous age. This contradiction requires clearing up. Meantime the possibility of a Fredericksburgian age for the *Nilssonia* bed is very intriguing because of the practical absence of fossils of Lower Cretaceous age in the Dominican Republic and Haiti, and elsewhere than Cidra in Porto Rico, and even there the evidence is not certainly proved. Further studies may prove the *Nilssonia* bed to be Upper Cretaceous.

The Archaeolithothamnium Antillean beds.—Fossil calcareous algae are abundant in certain deposits on St. Bartholomew, Antigua, Anguilla and Porto Rico. *Archaeolithothamnium affine* Howe was described by Dr. Howe from the Antiguan Oligocene, and was compared to *A. turonicum* from the Turonian stage of the Upper Cretaceous of France. The *Archaeolithothamnium* found by Mr. Hodge in the Coamo Springs algal limestone, Porto Rico, shows affinities with both the Oligocene *A. affine,* and with the Upper Cretaceous *A. turonicum,* hence its stratigraphic position can not be set by this alga alone. Dr. Coryell has reported *Archaeolithothamnium* also in limestones on the Coamo-Aibonito road, Porto Rico.

Flora of the Rio Collazo shales, Porto Rico.—This flora was found by Dr. Hollick to be very rich in dicotyledons, with palms abundant, but only two cycads were present, one fern and one alga. Dr. Hollick noted its typical New World facies, tropical character and Tertiary age.

From the molluscan evidence I refer the Rio Collazo flora to the Antiguan Oligocene.

The Siparia flora, Trinidad.—This flora was described by Dr. Hollick in 1924, but no age assigned. My own paleontological studies in Trinidad lead me to regard the Siparia flora as of Miocene age. But its exact position in that period is not determined.

The Los Quemados flora, Dominican Republic.—In 1916, the Maury Expedition collected *Eugenia, Nectandra, Inga* and various species of woods from the Gurabo formation on Rio Gurabo, near Los Quemados. This flora was shown by molluscan evidence to be of Middle Miocene age. An arm of the sea with rich molluscan and coral life occupied the present valley of Rio Yaque del Norte, while the neighboring shores were bordered with myrtles, laurels, mimosas and a variety of forest trees.

The Sánchez flora, Dominican Republic.—In 1921, the Vaughan Expedition obtained plants from the clays near Sánchez in the northeastern part of the Dominican Republic. This flora apparently is later than that of Los Quemados, but its exact horizon has not yet been determined. Dr. Vaughan referred it to Miocene or Pliocene.

The Rio Guajataca flora, Porto Rico.—A Post-Pliocene walnut was described by Dr. Hollick from the valley of Rio Guajataca, in 1926, and named *Juglans archaeoantillana.*

Antillean climates of the past.—Antillean fossil floras indicate that the West Indian climate has remained unchanged from Antiguan Oligocene time to the present day.

Antillean sea shells in Tertiary time were also tropical in character, for their living allies are inhabitants of warm seas. In a very few instances, however, competition has forced their modern descendants to the deep sea where they live in almost freezing water. For example, the modern analogue of *Crepitacella melanoides* Gabb of the Dominican Middle Miocene is *C. gabbi* Dall, living in ooze at 785 fathoms. With rare exceptions, the shells like the plants indicate that the temperature of the sea and of the air was similar to that of to-day in the Antilles.

In connection with Antillean stratigraphy, in reply to Professor Meyerhoff's criticism[6] of my recent paper,[7] I would say that my statement was based on the fact recorded by Dr. Vaughan[8] that R. T. Hill collected Caprinidae *in limestones* near Fajardo, eastern Porto Rico, and at Cape San Juan which forms the northeastern extremity of the island. I would also like to add that the identification of *Venericardia alticosta* Conrad, from the Rio Jueyes Water Gap, Porto Rico, was made by Professor Grabau, and hence is highly authoritative.

A further note on the age of the Porto Rican Sirenian may be of interest to vertebrate paleontologists. In 1915, Dr. Reeds found a fossil Manatee in the shales at the ford on Jacaguas River, one kilometer northeast of Juana Diaz, southern Porto Rico. This was named *Halitherium antillense* by Dr. Matthew, in 1916, but its age remained indeterminate. The invertebrate fauna of the Juana Diaz shales proves the Manatee to have lived in Antiguan Oligocene time.

CARLOTTA J. MAURY

[6] SCIENCE, 71: 322–3, March 21, 1930.
[7] SCIENCE, 70: 609, December 20, 1929.
[8] *Jour. Washington Acad. Science,* vol. 13, No. 14, 1923.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE FOURTEENTH ANNUAL MEETING OF THE PACIFIC DIVISION

By Dr. J. MURRAY LUCK, Secretary

THE fourteenth annual meeting of the Pacific Division of the American Association for the Advancement of Science and Associated Societies was held at the University of Oregon, Eugene, from June 18 to 21, 1930. The registration totaled 457, inclusive of 33 who attended the meeting of the Western Society of Soil Science held in Corvallis on the Monday and Tuesday preceding the Eugene meeting. Excellent hospitality was provided by the hotels of Eugene and the new dormitory of the University of Oregon. Over half of the members were thus cared for. Auto camps provided accommodation for 50. The remainder, many of whom were residents of Eugene and Corvallis, were guests in private residences.

The sessions commenced on the afternoon of June 18 with reviews of the scientific contributions of the past year. In accordance with the custom of recent years the speakers confined their attention to a few of the most significant papers contributed from the Pacific Coast and far western states. J. A. Anderson, of the Mount Wilson Observatory, and R. B. Brode, of the University of California, reviewed the physical sciences; Olaf Larsell, of the University of Oregon, and C. B. Lipman, of the University of California, surveyed the progress in the life sciences. This division of the field proved a happy one. Recognizing, as it did, the rapprochement that has been steadily growing among the sister sciences, it gave to the speakers in each group the wide domains of several interrelated sciences from which to sketch sweeping panoramic views of an entire field or details of a portion. At 4 P. M. two of the excellent sound films pre-

pared by the General Electric Company were presented. The four-reel film by Sir William Bragg on the "Arrangements of Atoms and Molecules in Crystals" and that of C. W. Hewlett on "Radioactive Rays" were the two selected by the committee in charge. About 250 attended these opening sessions.

From 5:00 to 6:30 P. M., Dr. Arnold Bennett Hall, president of the University of Oregon, and Mrs. Hall received the members and guests of the Pacific Division and Associated Societies. In the evening Dr. Hall formally welcomed the association to the university. In his address he stressed the value of the objective methods of science to the social disciplines and expressed a desire for closer relationships between the natural and social sciences. E. G. Martin, vice-president of the Pacific Division and chairman of the executive committee, responded to President Hall's message of welcome. Dr. Douglas H. Campbell, professor emeritus of botany in Stanford University and president of the Pacific Division, gave the address of the evening on "The Origin of Land Plants." It was published in full in the August 22 issue of this journal.

The morning of Thursday, June 19, was devoted to a symposium on "Forest Trees" in which most of the societies participating in the Eugene meeting joined. George W. Peavy, dean of the School of Forestry, Oregon State Agricultural College, presided. The introductory address on "Utilization Aspects" was given by Dr. Wilson Compton, of the National Lumber Manufacturers' Association, Washington, D. C. The speaker discussed the manifold uses of wood products, especially of the substances obtainable from cellulose. The potential value of lignin was also considered. Emphasis was given to the need of research on the properties of the important commercial woods and the means by which the desirable physical characteristics of wood could be modified or controlled and lumber thus made proof against decay, fire, insect attack, shrinkage and warping. T. T. Munger, of the Forest Experiment Station, Portland, Oregon, presented a paper on the "Ecological Aspects of the Transition from Old Forests to New." Reforestation in the Douglas fir region of Oregon and Washington was considered. The displacement of Douglas fir by hemlock and cedar, its reappearance in burned and logged land, and the rôle of drought, seed supply, temperature and animal enemies in this rebirth of the forest constituted the theme of the address. A paper by E. I. Kotok, of the California Forest Experiment Station, on "Fires, a Problem in American Forestry," was read by Dr. R. E. McArdle. The disastrous effects of forest fires in reducing the stands of economic worth and in affecting adversely the water supplies of dependent agricultural land areas were emphasized. Whole-hearted public support in the attempts of the forester to secure reasonable fire exclusion is needed. F. P. Keen, of the Forest Experiment Station, Portland, Oregon, spoke on "Forest Entomology" with particular reference to the dangers during the transition period from virgin to second-growth stands and the development of insect-resistant trees. A paper on "Forest Pathology" by E. E. Hubert, of the University of Idaho, was read in Professor Hubert's absence by Dr. Barss, of Oregon State Agricultural College. Control methods for the exclusion or eradication of the most important fungus diseases in the Pacific Northwest were considered. All speakers stressed the need of scientific study and control in the development, protection and utilization of the forests.

The evening of June 19 was devoted to an address by Professor A. E. Douglass, of the University of Arizona, on "Tales Told by Tree Rings." The speaker described the well-known studies conducted by himself and his collaborators in which an analysis of tree rings in the semiarid regions of the Southwest has given a complete chronological record extending back to A. D. 780. By the use of this scale it has proved possible to assign exact dates to the ancient pueblos and Indian ruins of Arizona and New Mexico. The subject was suitably illustrated with slides and motion pictures.

The concluding evening address was presented on Friday, June 20, by W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, Swarthmore, Pennsylvania, on "Philosophic Concepts in Modern Physics." Vivaciously and with much humor the speaker dwelt upon the nature and trend of several phases of theoretical physics—the relativity concept in particular.

In addition to the regular scientific sessions which extended over Thursday and Friday, a number of excursions to places of special interest were arranged. A paleo-botany expedition to rich fossil beds south of Eugene attracted a large party on Thursday afternoon. This was led by Dr. Ethel Sanborn. Trips to the Springfield Lumber Mill, the State Game Farm and the Power Plant and State Fish Hatchery at Leaburg proved to be of great interest. On Saturday a party of 50 motored to the lava beds in the region of the McKenzie Pass. This trip led along the beautiful McKenzie River into the foothills of the Upper Cascades. Through the courtesy of the Obsidian Club of Eugene guides were provided for those desirous of climbing one of the snow-capped peaks in the high Cascades. Eleven participated in this outing, which extended over Saturday and Sunday, June 21 and 22. On Friday afternoon approximately 200 availed them-

selves of an opportunity to visit the Oregon State Agricultural College at Corvallis.

Business sessions of the Pacific Division, the executive committee and the affiliation committee were held during the course of the meetings. At the general business session on June 19, successors were elected to the two retiring members of the executive committee. O. F. Stafford, of the University of Oregon, was elected to succeed himself, and J. H. C. Smith, of the Carnegie Laboratory of Plant Biology, Stanford University, was appointed to fill the vacancy created by the retirement of Professor J. O. Snyder. A resolution of gratitude for the gracious hospitality extended by the University of Oregon was unanimously adopted. Announcement was made that the meeting of 1931 would be held in the month of June in Pasadena, California. The affiliation committee, consisting of representatives of the Affiliated Societies, reported on the decisions of the various societies in the matter of participating in the special winter meeting of the Pacific Division. This is to be held at Stanford University, December 22 and 23, 1930. It is designed primarily for the benefit of societies unable to meet in the summer and for such other societies as regard the additional meeting advantageous. At the meeting of the executive committee, on June 20, T. Wayland Vaughan, director of the Scripps Institution of Oceanography of the University of California, was elected president of the Pacific Division for the year 1930–31. E. G. Martin was reelected vice-president and chairman of the executive committee, and J. Murray Luck, secretary-treasurer, for terms of three years.

O. F. Stafford, Paul Ager, E. M. Pallett and J. F. Bovard served as chairmen of the committees in charge of local arrangements.

The reports of the scientific sessions of participating societies follow.

American Association of Economic Entomologists, Pacific Slope Branch

(*Report by J. C. Elmore, Acting Secretary*)

Chairman Don C. Mote opened the sessions with a paper on the food of China pheasants, showing that while the major portion is weed and waste crop seed, the animal portion consists of arthropods, most of which are insects. H. E. Burke reported on the relative importance of insect pests of ornamental and shade trees of the Pacific states. J. C. Elmore's paper indicated a close relationship between winter temperatures and the development of host plants of the pepper weevil, which in turn influenced the degree of infestation on the following commercial crop. R. L. Webster showed that two species of Epitrix varied greatly in abundance in different parts of Washington. H. A. Scullen reported that bumblebees occurred from sea-level to the snow line in Oregon, and were common except in arid uncultivated areas. Leroy Childs gave an account of the successful introduction of the woolly aphis parasite, *Aphelinus mali*, into the Hood River Valley. L. P. Rockwood reported on the distribution and damage of a seed caterpillar on native clover. B. G. Thompson reported the discovery of the dusky veined walnut aphis in Oregon in 1928 and its subsequent spread. W. J. Chamberlain gave a synopsis of the insects which cause defects in wood or attack materials used by the engineering profession. R. E. Dimmick discussed laboratory methods of teaching entomology. J. R. Eyer's paper reported on cane or corn syrup baits for the codling moth in New Mexico, and that certain esters increased their attractiveness. E. J. Newcomer gave an account of the damage to pears and apples from codling moth eggs hatching after the fruit is picked and showed that this might be prevented by an oil emulsion treatment. Anthony Spuler reported on codling moth activity in the Wenatchee Valley as shown by trap records. Trevor Kincaid reported on the control of the earwig by the European ground beetle, and of the European brown scale by chalcid parasites. J. Wilcox reported on experiments with baits for strawberry root weevils in Oregon, and E. R. de Ong gave an account of the preparation and use of pine tar oils as insecticides and fungicides. Officers for the coming year are Roy E. Campbell, *chairman;* H. E. Burke, *vice-chairman;* H. A. Scullen, *secretary-treasurer.*

American Chemical Society—Pacific Intersectional Meeting

(*Report by O. F. Stafford, Chairman of Program Committee*)

The third Pacific Intersectional Meeting of the American Chemical Society was held in conjunction with the Pacific Division of the American Association for the Advancement of Science at its meeting at the University of Oregon, Eugene, Oregon, June 19 and 20, 1930. The participating sections were California, Northwest Utah, Oregon, Puget Sound, Sacramento, Southern California and Washington-Idaho Border.

The opening session was devoted to the presentation of three papers of a general nature. The first of these, "Isotopes and Band Spectra," was by R. P. Birge, of the University of California. The second, "The Application of X-Ray to Chemical Problems," was by Maurice L. Huggins, of Stanford University, while the third, "The Concepts of Physical Chemistry in Investigations of Vital Processes," was by L. B. Becking, of the Hopkins Marine Station, Pacific Grove, California.

Following the general session were meetings of the

two groups composed, respectively, of those interested in general and physical chemistry, upon the one hand, and organic and biochemistry upon the other. Twenty-four papers were read before the first of these groups and twenty-six before the second.

GROUP I

General and Inorganic Chemistry, Physical Chemistry, Analytical Chemistry, Industrial Chemistry

The measurement of the absolute amount of absorption at the air-water interface: J. W. MCBAIN and C. W. HUMPHREYS, Stanford University.

Phase rule equilibria of horse serum globulin: ELOISE JAMESON, Stanford University.

A study of the emulsifying properties of gelatin: DONALD N. EVANS and LEO FRIEDMAN, University of Oregon.

A simplified glass electrode apparatus: G. ROSS ROBERTSON, University of California at Los Angeles.

The measurement of turbidity with a thermocouple: E. D. MCALISTER, University of Oregon.

Hydrazino-salts: R. E. KIRK and A. I. DE LEON, University of Montana.

The calcium-chlorinity and magnesium-chlorinity ratios of sea water: THOMAS G. THOMPSON and CALVERT C. WRIGHT, University of Washington.

The sulphate-chlorinity ratio of sea water: THOMAS G. THOMPSON and WILLIAM R. JOHNSTON, University of Washington.

Research for the undergraduate: R. E. KIRK, University of Montana.

Studies on the structure of cellulose fiber: FLOYD VAN ATTA and LEO FRIEDMAN, University of Oregon.

The production of wood pulp in the Pacific Northwest: H. K. BENSON, University of Washington.

An upper limit for the absolute potential of the normal calomel electrode: OTTO KOENIG, University of California.

Conductance and activity coefficients of aspartic and glutamic acids and their sodium salts at 0°: W. M. HOSKINS, MERLE RANDALL and CARL L. A. SCHMIDT, University of California.

The effect of iodine chloride on the photosynthesis of hydrochloric acid: G. K. ROLLEFSON and F. E. LINDQUIST, University of California.

The sensitized photosynthesis of carbon dioxide at low chlorine pressures: G. K. ROLLEFSON, University of California.

Cyclic chlorine in waters from certain sections of Western Oregon: LOUIS C. RAYMOND and ROBERT A. OSBORN, Oregon State College.

Some factors affecting the composition of dry lime-sulphur solutions: D. E. BULLIS, Oregon Agricultural Experiment Station.

Determination of strontium in sea water: THOMAS G. THOMPSON and BERTRAM D. THOMAS, University of Washington.

The acid requirement of sea water: THOMAS G. THOMPSON and ROBERT U. BONNAR, University of Washington.

Principles determining the arrangement of atoms and ions in crystals: MAURICE L. HUGGINS, Stanford University.

More efficient laboratory instruction in general chemistry: W. E. BRADT, Washington State College.

Cyanourea as a mixed aquo ammono carbonic acid: G. E. P. SMITH and J. S. BLAIR, Stanford University.

The transition between the glassy and liquid states: GEORGE S. PARKS, H. M. HUFFMAN and S. B. THOMAS, Stanford University.

A molten salt mixture process for the treatment and hardening of steel: T. L. MEADOR.

GROUP II

Organic Chemistry, Biochemistry, Agricultural Chemistry

The arrangement of atoms in organic molecules: MAURICE L. HUGGINS, Stanford University.

Observations on the chemical constitution of carotene and xanthophyll: JAMES H. C. SMITH and H. A. SPOEHR, Stanford University.

An apparatus for percolation at a uniform constant rate, and a device for automatically collecting the percolate in a series of receivers: P. L. HIBBARD, University of California.

Some reactions of the ketimines: G. E. P. SMITH, Stanford University.

The use of oxygen values in sea water pollution studies: H. K. BENSON, University of Washington.

Optically active pinenes from western woods: R. C. THIELKE and F. H. THURBER, Oregon State College.

Bound water in hydrophilic colloids: J. L. ST. JOHN and J. S. CARVER, Washington Agricultural Experiment Station.

Synthetic rations for chicks: J. S. CARVER and J. L. ST. JOHN, Washington Agricultural Experiment Station.

Arsenic and lead in apples and pears: J. S. JONES, Oregon Agricultural Experiment Station.

The biological value of leaf proteins: J. R. HAAG, Oregon Agricultural Experiment Station.

A study of the physical and chemical properties of commercial arsenates of lead as they may effect the control of codling moth: R. H. ROBINSON, Oregon Agricultural Experiment Station.

Structure symbols and their interpretation: INGO W. D. HACKH, College of Physicians and Surgeons, San Francisco, California.

Further study of the negative catalytic effect of alcohols in the reaction of Grignard reagents with carbonyl compounds: C. R. KINNEY, University of Utah.

The properties of some tri-aryl selenonium salts: H. M. LEICESTER and F. W. BERGSTROM, Stanford University.

Studies on the antimony trichloride colorimetric assay of vitamin A: 1. Effect of concentration of reagent upon color produced: EARL R. NORRIS and ANNA E. CHURCH, University of Washington.

Studies on the antimony trichloride colorimetric assay of vitamin A: 2. Effect of light and temperature upon the stability of the chromogen: EARL R. NORRIS and ANNA E. CHURCH, University of Washington.

The effect of the destruction of vitamin A by dilution oils upon the accuracy of the determination by biological and colorimetric methods: EARL R. NORRIS and ANNA E. CHURCH, University of Washington.

The composition of mesquite gum: LOUIS OTIS, University of Arizona.

A study of the chemical properties of quinoxaline: R. A. OGG and F. W. BERGSTROM, Stanford University.

The chemical properties of 2, 3 dimethyl and 2, 3 diphenyl quinoxaline: R. A. OGG and F. W. BERGSTROM, Stanford University.

The composition of flaxseed mucilage: J. A. CROWDER, University of Arizona.

The adsorption of organic nitrogenous compounds at different hydrogen ion concentrations: JOHN H. TRUESDAIL and ROGER J. WILLIAMS, University of Oregon.

The effect of Jansen and Donath's antineuritic vitamin on yeast growth: RICHARD R. ROEHM and ROGER J. WILLIAMS, University of Oregon.

Toxic effects of fish liver oils: EARL R. NORRIS and ANNA E. CHURCH, University of Washington.

Utilization of a sensitive thermocouple in the determination of the red cell content of blood: RICHARD R. ROEHM, EDWARD D. MCALISTER and ROGER J. WILLIAMS, University of Oregon.

Enolic modifications of pyridines and quinolines alkylated in 2 or 4 positions: F. W. BERGSTROM, Stanford University.

A feature of the meeting at Eugene was an intersectional contest between competing teams of high-school students representing the states of California and Oregon. These teams, each of which had been selected by preliminary elimination contests, were from the high schools at Roseville, California, and Hood River, Oregon, respectively. The contest was conducted by Dr. C. R. Kinney, of the University of Utah. The trophy was awarded to the Hood River team.

On Thursday evening a chemists dinner was held at which over a hundred were in attendance.

At the business session Dr. G. Ross Robertson, of the University of California at Los Angeles, was elected to the intersectional committee to succeed Professor J. H. Norton, of Sacramento Junior College, whose three-year term expires. The personnel of the intersectional committee for the coming year is therefore as follows: George S. Parks, Stanford University, *chairman;* O. F. Stafford, of the University of Oregon, and G. Ross Robertson, the newly elected member. Dr. Robertson is to be chairman of the program committee for the intersectional meeting to be held next year at Pasadena.

AMERICAN MATHEMATICAL SOCIETY

(*Report by E. E. De Cou, Acting Secretary*)

The session was held on Friday morning, June 20, in the Administration Building of the University of Oregon. The total attendance was about forty persons, of whom nineteen were members of the society. Twenty-five papers were presented. A revision of the by-laws of the society, proposed at the recent meeting of the society at Chicago, which had to lie over under the rules, was finally adopted at this meeting, which now ranks as a national meeting of the society. Those who presided were President E. R. Hedrick and Professors E. T. Bell, H. F. Blichfeldt and R. E. Moritz. A luncheon was served at noon in the dining-room of the university, and was followed in the afternoon by an automobile trip to the Oregon State College.

AMERICAN METEOROLOGICAL SOCIETY

(*Report by Edward L. Wells, Secretary for Eugene Meeting*)

On the afternoon of June 19 Major Edward H. Bowie discussed nocturnal radiation and stratus cloud formation on the Pacific Coast. Because of the fact that humid air radiates heat more rapidly than drier air instability is brought about in the humid stratum, the cooling being greatest in its upper portion. This results in convection, cloud and in many instances rain. Lieutenant V. O. Clapp described the apparatus used in obtaining upper air soundings and described the conditions attending the formation of ice on airplanes. A paper written by Thomas R. Reed, on "Aviation Weather Hazards," was read by Edwin H. Jones. The weather is the outstanding problem confronting flying operations; serious weather hazards are two—fog and sleet. This was followed by a general discussion of the relation of meteorology to aviation, led by Major Bowie and participated in by Messrs. Jones, Freeman, Wells, Dague, Douglass, Clapp and Breese. A. E. Douglass gave an address on recent weather cycles. He has worked over a long series of tree growth curves and finds that the only long cycles that exist in these are multiples of the sunspot cycle of eleven years. E. T. Allen, of the Western Forestry and Conservation Association, was introduced, and spoke of the fire weather forecasts of the Weather Bureau.

On Friday morning Edwin H. Jones outlined some of the climatic peculiarities of the Yakima Valley. It is rather a series of valleys. The most pronounced adiabatic and radiational effects in the behavior of temperatures must be expected. The most favorable formation for precipitation is just after the center of the storm has begun to pass eastward. A paper on "Experiments with an Automatic Psychrometer," by Eckley S. Ellison, was read by title. Edwin T. Hodge discussed Tertiary changes in the climate of Oregon, producing evidence of two periods of glaciation. An abstract of a paper by E. M. Keyser, on "An Inland Empire Long-period Precipitation Riddle," was given

by the acting secretary. Tree ring growths in Bonner County show alternate wet and dry periods of from 20 to 40 years, with the recent dry period, since 1885, as the driest of all, while the lakes in Spokane County, Washington, seem to indicate that the earlier years were drier than recent years. A paper on "Tulare Lake," by C. E. Grunsky, was read by the secretary. Facts cited were taken to indicate that the climate is not necessarily undergoing permanent changes, but there may yet be periods without excessive precipitation, followed by periods in which wet years will be frequent. J. M. Adams showed pictures representing early stages in the growth of snowflakes, explaining how the twinning of crystals in the formative process was responsible for keeping certain crystals upright, resulting in various types of optical phenomena.

A luncheon of meteorologists and their friends was given at The Anchorage. Following the luncheon there was an informal discussion, participated in by those who had done meteorological work in out-of-the-way places of the earth, or who had had experiences, related to meteorology, in those places.

In the afternoon a paper on "Forest Tree Diseases Caused by Meteorological Conditions," by E. C. Hubert, was read by title. A. G. Simson discussed relative humidity and short period variations in fuel moisture content. A knowledge of the degree and rapidity with which the various kinds of forest fuels respond to relative humidity is essential to good slash burning technique, and should aid in the proper disposition of fire suppression forces. R. E. McArdle said that the lag of fuel moisture content behind atmospheric humidity was less than formerly supposed. O. W. Freeman presented a new rainfall map of Washington. All the available records were used, supplemented by the results of personal observations of relief and vegetation. C. I. Dague gave an account of the disastrous fire weather of September, 1929. The worst drought in the history of Weather Bureau records prevailed from June 20 to December 7. More than 90 per cent. of the fire losses for the season occurred after September 6. For the first time in the history of organized protection it was necessary to maintain patrol forces until the first week of December. The closing paper was one by G. W. Alexander, distinguishing between fire weather and fire climate and giving suggestions for standardizing methods of making permanent record of weather in its relation to fire hazards.

Resolutions were adopted thanking various organizations for courtesies extended, suggesting that the *Bulletin* of the society give less attention to reports of airplane disasters and urging the foundation of an institute for meteorological research, international in character.

American Physical Society

(Report by R. B. Brode, Acting Secretary)

The one hundred and sixty-fourth regular meeting of the American Physical Society was held in Eugene, Oregon, on Thursday and Friday, June 19 and 20, 1930. The Thursday afternoon program was held jointly with the Astronomical Society of the Pacific. The program of the joint session consisted of three papers, by invitation, on the general topic, "The Red Shift in the Spectra of Distant Light Sources and Its Physical Interpretation." M. L. Humason, of the Mount Wilson Observatory, spoke on "The Apparent Velocity Shifts in the Spectra of Faint Nebulae," and E. Hubble, of the Mount Wilson Observatory, spoke on "The Distance of Nebulae and Their Correlation with Apparent Velocities." R. C. Tolman, of the California Institute of Technology, discussed "The Significance of the Velocity Distance Relation from the Standpoint of General Relativity."

Twenty-five papers were presented in the Friday morning and afternoon sessions. Titles and abstracts of these papers are printed in the *Bulletin* of the American Physical Society.[1] A luncheon was held Friday noon at the Hotel Osborn.

The one hundred and sixty-seventh meeting of the American Physical Society will be held at the University of California at Los Angeles on December 12 and 13, 1930. The session on Friday afternoon, December 12, will be a joint meeting with the Acoustical Society of America.

American Phytopathological Society—Pacific Division

(Report by B. A. Rudolph, Secretary)

Three half-day sessions were held. At a business meeting the following officers were elected to serve the society during the next two years: Eubanks Carsner, *president;* J. M. Raeder, *vice-president;* B. A. Rudolph, *secretary-treasurer;* C. E. Owens, *councilor.*

T. E. Rawlins and W. T. Horne showed that buckskin of sweet cherries may be transmitted by grafting diseased scions upon healthy root stocks. A. R. C. Haas described pathological changes induced in sand and water cultures of citrus species by a deficiency of boron, which apparently is essential to the translocation of carbohydrates. L. J. Klotz and E. C. Raby reported inoculation experiments with an apparently new fungus disease of date palm inflorescences. While greatly resembling "Khamedj" of African dates the California disease also displays distinct differences from the other. W. N. Takahashi and T. E. Rawlins have found the electrophoretic behavior of tobacco mosaic virus to be similar to that reported by other workers for bacteria. W. T. Horne

[1] Vol. 5, No. 3, issued June 6, 1930.

and E. R. Parker have succeeded in producing "sun blotch" in healthy avocado trees by grafting diseased scions upon them. The disease, apparently an infectious chlorosis, thus far has resisted transmission by any other method. J. S. Cooley found that pears and apples wrapped in papers treated with a 2½ per cent. solution of hydrated copper sulphate are protected from *Botrytis* rot which will readily penetrate fruit wrapped in untreated papers. J. H. Crenshaw has determined how long after application Bordeaux mixture may be expected to prevent germination of spores of the perennial canker fungus. J. Cooley and P. W. Miller have shown that, while perennial canker in apples may follow mechanical wounds and abrasions, entrance of the causal organism is greatly enhanced by the presence of winter injuries. C. O. Smith and J. T. Barrett reported their studies of the susceptibility of various species of black and English walnuts to *Phytophthora*-like fungi. *Juglans californica* was found to be the most susceptible of all. H. P. Barss described original formaldehyde treatments which prevent decay in fruits in transit. Various other materials used experimentally without success were enumerated. Barss also reported a serious outbreak of brown rot in cherries in the Willamette Valley, Oregon, in 1929 and 1930 due chiefly to *Sclerotinia cinerea* (Bon.) Schröt. forma *pruni* Wormald rather than to the American form, *Sclerotinia fruticola* (Wint.) Rehm. (= S. americana Nort. & Ezek.). L. K. Jones has found that spread of "streak" in tomatoes may be greatly reduced in greenhouses by disinfecting pruning shears and carefully washing the hands frequently with soap and water when working with the plants. G. Burnett and L. K. Jones have succeeded in producing "streak" easily in tomato plants by rubbing them with the juice of apparently healthy potato tubers mixed with juice from mosaic tobacco plants. But juice from potato seedlings mixed the same way did not produce the disease. F. D. Heald and K. Baker reported a serious rot of tulip bulbs, proved experimentally to be due to a *Penicillium* sp. which was able to rot apples but not gladiolus bulbs. S. M. Zeller discussed a recent paper of his[2] which establishes proof of the greater susceptibility of raspberry previously attacked by yellow rust (*Phragmidium imitans*) to cane blight (*Leptosphaeria coniothyrium*). Zeller also described a witches broom of ocean spray (*Holodiscus discolor* Max.) which is believed to be of virus origin. T. P. Dykstra succeeded in transmitting potato leaf rool to tomato, pepper, *Datura stramonium, D. tatula, Solanum nigrum* and *S. dulcamara*. By means of infected aphids (*Myzus persicae*) many successful cross-inoculations were made. L. N. Goodding has found a new species of *Didymosphaeria* parasitic on alder trees which he has named *D. oregonensis Goodding*. B. A. Rudolph has found that bacterial blight of walnuts can be controlled within practical limits with Bordeaux 8–4–50, the lime being reduced as per formula.

[2] *Jour. Agr. Res.*, 34: 857–863, illus., 1927.

American Society of Ichthyologists and Herpetologists—Western Division

(*Report by G. S. Myers, Secretary*)

At the Berkeley meeting of the association, 1929, a group of western members of the society formed a Western Division of the organization with the following officers: J. O. Snyder, Stanford University, *president;* R. L. Bolin, Hopkins Marine Station, *vice-president,* and G. S. Myers, Stanford University, *secretary-treasurer.* A winter meeting was held at the Hopkins Marine Station, Pacific Grove, December 20, 1929.

At the first annual meeting, at Eugene, June 19, 1930, 1:30 P. M., there was a short business session at which the officers for the ensuing year were elected, as follows: W. F. Thompson, International Fisheries Commission, *president;* P. H. Pope, Whitman College, *vice-president,* and G. S. Myers, Stanford University, *secretary-treasurer.*

Exhibits of living material were as follows: Amphibians, *Ascaphus truei, Ambystoma decorticatum,* adults and larvae, *A. paroticum,* adults and larvae, *A. macrodactylum* and *Ensatina eschscholtzii,* all by J. R. Slater, College of Puget Sound; Fishes, *Empetrichthys merriami,* by G. S. Myers, Stanford University.

Papers Presented

Races of Halibut: W. F. THOMPSON, International Fisheries Commission. Marking experiments indicate that the halibut population of the Northeast Pacific is broken into small units of non-migratory immatures and larger composite units of migratory matures over eleven years old. Each unit of both types has distinctive physical characteristics of doubtful meaning to the systematist because of changed grouping with age and some interchange between units. These units are depleted independently and are thus important to regulatory laws.

Notes on the habits of a rare East Indian Eel: ALBERT W. HERRE, Stanford University. A vast colony of the rare eel, *Heteroconger polyzona,* has been discovered in the coral sands at Dumaguete, Oriental Negros, P. I. Each eel has its own burrow, the holes arranged in pairs. This is the first record of the species since its discovery at Amboina in 1868.

A study of certain measurable characters for comparisons of Salmonoid fishes in western Washington: LOYD ROYAL, University of Washington.

The fisheries of the East Indies: ALBERT W. HERRE, Stanford University. The commercially most important single species is *Chanos chanos,* raised in salt-water fish

ponds in the Philippines. The most important family is the Clupeidae. Attention is directed to the great opportunities awaiting development of the sardine, tuna, bonito and albacore fisheries.

A statistical study of the growth of the lamprey, Lampetra planeri, from Western Washington: LEONARD P. SCHULTZ, University of Washington.

Distribution of the true fresh-water fishes of the western United States: J. O. SNYDER, Stanford University. The fresh-water fishes of the Pacific Slope fall into six general faunal groups, as follows: the Columbia, Klamath, Sacramento-San Joaquin and Colorado river-systems, and the two interior basins of old Lakes Lahontan and Bonneville. Most of these each have a few peculiar genera and a series of allied species of certain genera, these showing definite relationships between the basins.

ASTRONOMICAL SOCIETY OF THE PACIFIC

(*Report by W. E. Harper, Chairman of the Program Committee*)

Two forenoon sessions were given over to the astronomical papers, of which there were 28 presented. Aitken's new general catalogue of double stars (A. D. S.), now in press, will contain 17,181 entries. Nicholson and (Miss) Sternberg reported that the solar activity is decreasing, being definitely less in 1929 than in 1928. Marked fluctuations were found having a period of about 15 months. Hill gave the orbital elements of the spectroscopic binary 103 Tauri, while Harper reported on four orbits of A-type spectroscopic binaries whose periods ranged from 1.5 to 4.2 days. Neubauer at Santiago has been taking spectra of stars fainter than magnitude 5.5 and radial velocity results for 354 are now available, 180 of which are of B-type. Pearce and Plaskett gave details of a catalogue of radial velocities of 0 to B5 stars numbering 996 in all which have been determined to date at all observatories. Using the velocities for 680 of these stars Pearce has made a new determination of the solar motion, galactic rotation and K term. Humason and Christie described the spectra of two F-type stars showing bright lines. One was constant in velocity; the other a spectroscopic binary. Considerable interest was centered around the new object found at the Lowell Observatory, and Slipher reported on its discovery and the early orbital computations. Whipple gave his own recent determinations of the orbit utilizing the new data accruing from the discovery, some ten days previous to the meeting, of the object on Mount Wilson plates of 1919. The results of Nicholson and Mayall from the same data were almost identical with Whipple's, and the eccentricity of 0.256 so determined, coupled with the fact that Mount Wilson has found for it a spectrum more or less of solar type, should lessen the opposition to its being considered a planet. From long exposure photographs with the 60-inch reflector on the planets Uranus and Saturn, Christie had concluded that no additional satellites of these planets existed which were brighter than 18.5 magnitude. Miss Hayford determined the orbit of comet 1930 d and found it to resemble that of Daniel's comet of 1909. Menzel has studied the spectra of the outer planets in which marked absorption bands occur and seems to feel that these are due to hydrogen, oxygen or water. Moore reported on the solar eclipse expedition to Camptonville on April 28. Photos of the flash spectrum were obtained as well as direct photos, the latter suggesting that the eclipse there was annular, not total. Efforts by Jeffers from an aeroplane to photograph the moon's shadow on the ground were unsuccessful. Similar work attempted by Brackett with observers in two army aeroplanes at altitudes approximately 19,000 feet showed that the method was hopeful.

In the second forenoon session Beals outlined a suggested classification of Wolf Rayet stars which will run approximately parallel to the corresponding subdivisions for absorption 0's. Redman obtains evidence for a rotation of the line of apsides in the binary Y Cygni, in confirmation of earlier photometric work. Pictures were shown by Adams of the 50-foot interferometer recently completed at Mount Wilson, and tests made on Betelgeuse and Arcturus give results in agreement with those obtained with the 20-foot. Continuing the experiments on ether drift with instrumental equipment whose sensitivity is 100 times as great as that used by Miller, Pease and his associates show that the effect Miller found could be due to errors in the instrument. St. John reviewed the evidence for the Einsteinian displacement of spectral lines and concluded that the general theory of relativity must now be accepted. Joy finds that the period of the eclipsing variable U Sagittae is not constant. From a study of open star clusters Trumpler finds that, contrary to accepted opinion, absorption of light takes place in our stellar system. Intergalactic space is, however, highly transparent. By counting the number of lines of each intensity in the solar spectrum Babcock finds that the abundance increases smoothly as we proceed from high intensity to low. Wave-length determinations made in furnace and arc spectra for the stronger lines of the rare earths have furnished King at Mount Wilson with additional data as to the presence of these lines in the solar spectrum. By using high dispersion spectra of bright stars Sanford and Adams find a variation of radial velocity with excitation potential. Spectra of the interesting 27-year period eclipsing variable *epsilon* Aurigae were shown by Adams and Sanford.

These were made with very high dispersion and showed the lines double in November, 1929, and February, 1930.

While important researches are embodied in the papers so briefly referred to, the reading and discussion of which were of much value to those present, it might be considered by some that the joint meeting of mathematicians, physicists and astronomers on the Thursday afternoon was of even greater value. This was in the nature of a symposium on the subject "The Red Shift in the Spectra of Distant Light Sources and its Physical Interpretation." Humason, of the Mount Wilson Observatory, detailed the observational evidence obtained of these great line shifts; Hubble, of the same observatory, correlated such apparent velocity displacements with the distances of the objects, while Tolman, of the California Institute of Technology, gave a mathematical discussion showing how such line shifts need not be considered as velocity displacements in the ordinary sense but rather shifts explainable by the excessive radiations of these distant objects.

THE BOTANICAL SOCIETY OF AMERICA—PACIFIC DIVISION

(*Report by E. T. Bartholomew, Secretary*)

E. T. Bartholomew, of the University of California, Citrus Experiment Station, Riverside, was elected president, and LeRoy Abrams, of Stanford University, secretary for the coming year. Besides participating in the general sessions of the Pacific Division, the botanical section held an afternoon session which was devoted to the reading and discussion of papers. L. G. M. Baas-Becking presented data which showed that the walls of the geniculi of Amphiroa and Corallina are non-cellulosic, probably pectin or a derivative, while the articuli are calcified. A study of the geniculi showed the walls to be built of isotropic, concentric lamellae. The only mineral deposited by the young cells is calcite. In her paper on "The Eocene Trees of the Oregon Region," Ethel I. Sanborn reported that the records indicated a warm temperature for the Comstock beds and a subtropical temperature for the Goshen beds. G. R. Johnstone and T. S. Clare discussed the proper chilling periods and temperatures for the optimum germination of the seeds of various species of Pinus. G. R. Johnstone and F. W. Newton reported the finding of various amounts of carbon monoxide in the pneumatocysts of *Pelagophycus porra*, the maximum amount being 3.59 per cent. Ansel F. Hemenway's findings indicate that while root activity in deciduous trees may cease during the winter such is not the case for conifers. *Phragmites communis* has been found in a new locality in the State of Washington, according to B. G. Rigg. According to William E. Lawrence, the brown algae, although their habitat is confined to sea water, have attained many, if not most, of the developments found in the higher plants. That the organic materials in the higher plants may pass along the walls rather than from cell to cell was indicated by evidence presented by A. S. Crafts. A. S. Mulay presented further data on the seasonal variations in nitrogenous compounds in pear shoots. E. T. Bartholomew reported preliminary studies on Citrus leaf.

ECOLOGICAL SOCIETY OF AMERICA

(*Report by W. E. Lawrence, Acting Secretary*)

A single session was held on the afternoon of June 20. W. E. Lawrence, of Oregon State College, presented a paper on the criteria in the classification of growth-forms and the synonymy of the terms employed. L. F. Henderson, of the University of Oregon, reported on the distribution of the genus *Erythronium* in Oregon, and hybridization between *E. giganteum* and *E. Hendersoni*. The marked ability of the prothallia of many ferns to withstand severe and prolonged drought was described by F. L. Pickett, of Washington State College; W. C. Lowdermilk, of the California Forest Experiment Station, discussed some of the relationships of vegetation to soil development and erosion. A paper by Vera Smith Davidson, of Stanford University, on "Seasonal Relations of Animal Species and Total Populations in a Deciduous Forest Succession" was read by title.

SOCIETY OF AMERICAN BACTERIOLOGISTS

(*Report by H. J. Sears, President, Oregon Branch*)

An informal meeting of the Society of American Bacteriologists was held on June 20, under the auspices of the Oregon Branch. Both a morning and an afternoon session were necessary to complete the program which consisted of sixteen papers. The average attendance for both sessions was approximately 25 persons. Four of the papers were read by title only. In a very interesting paper on "Bacterial Adaptations" Dr. Victor Burke showed that certain organisms could, by selection, acquire a heat resistance that was not easily lost. He was reluctant to call this mutation, however. Bacteria of the sea, according to Burke, are merely land or fresh-water forms that have adapted themselves to marine conditions. Dr. Weinzirl reported that, by a refined technique of measuring pH, evidence was obtained of the utilization of dextrose by many of the so-called nonfermenters. Professor Charlton, of Oregon State College, reported some interesting studies on chlorine resistant species of Pseudomonas isolated from swimming pools, and believed their origin to be the raw

water. Dr. Parker's paper describing the wide distribution of Rocky Mountain spotted fever in the western states was the center of much interest in this program, the Northwest being the most seriously affected area. Interesting facts relating to the tubercle bacillus were reported by Dr. Weinzirl. Desensitization of tuberculous guinea-pigs he believes to be an accomplished fact, and the existence of a waxy envelope as a protective covering for the organism is a myth that should be discarded from our writing and thinking. Undulant fever comes in for its share of consideration, a skin test with definite promise in diagnosis being reported by Dr. Levin, and a study of incidence in the Portland area being discussed by Dr. Sears and his pupils. An important contribution to our knowledge of the bacteria responsible for sinusitis in children was made by Mr. Frick, of the University of Oregon Medical School, and Miss Strube, of the same institution, reported the incidence of syphilis in this community to be in the neighborhood of 8 per cent. as deduced from the results of some 12,000 Wassermann tests.

SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE—PACIFIC BRANCH

(*Report by E. G. Martin, Secretary pro tem*)

A meeting of this society was held on Thursday afternoon, June 19, beginning at 1:30 P. M. About 40 persons were in attendance. Dr. G. E. Burget, professor of physiology of the Oregon Medical School, acted as presiding officer for the meeting. Twelve papers were presented, and five others read by title. Seven of the papers were from the University of Oregon Medical School. Dr. William F. Allen reported a method of obtaining experimental arhythmia (pulsus bigeminus) in rabbits. Doctors Harold B. Myers and Warren C. Hunter showed that renal capsulectomy had little, if any, demonstrable effect either on renal function or on the regeneration of tubular epithelium in acute mercuric chloride nephritis. G. E. Burget and Karl Martzloff reported that survival of many months could be obtained in animals in which closed loops of the small intestine had been set off and the continuity of the main intestine restored. In order to secure survival it was necessary to drain the closed loops at intervals. E. G. Martin, Eola Woolley and Miriam Miller reported that in the gracilis muscle of the dog about twice as many capillaries can be injected with India ink when the muscle is exercised as when it is at rest. Edwin Osgood described an improved technique for the detection of Bence-Jones' proteinuria. I. A. Manville showed that under certain conditions a greater yield of vitamin D was obtained when the intensity of radiation was reduced than when radiation of maximum intensity was employed. Frank R. Menne described histologic changes in the thyroid glands of rabbits following the introduction of various substances into the circulation. M. R. Amsden, A. C. Daniels and J. M. Luck found that when insulin was administered subcutaneously to normal fasting male adults the amino acid nitrogen of the blood was reduced by 20 per cent. Olaf Larsell found that when one eye was extirpated in larvae of the tree frog the cells of the opticus layer failed to attain the same size as corresponding cells of the opposite side. The effect was attributed to absence of nerve stimuli as a consequence of removing the eye. Dr. C. P. Stone reported from studies of rats subjected to cortical lesions that native responses (copulatory and maternal behavior) appear to be mediated primarily by subcortical brain centers in contrast with learned responses which are very dependent on cerebral cortex for their performance. Mary L. Smull, F. M. Baldwin and associates subjected individuals to prolonged mental effort over a series of days. A significant rise in the metabolic level was observed on the third and succeeding days. Dr. F. M. Baldwin described a method of obtaining aliquot samples of the expired air permitting determinations of respiratory volumes with the use of 1000 cc glass cylinders.

WESTERN SOCIETY OF NATURALISTS

(*Report by C. V. Taylor, Secretary*)

Two half days were devoted to the presentation of papers. J. R. Slonaker reported further investigations on protein requirements in the albino rat, indicating an optimum of 14 per cent. protein diet for young weaned animals but a higher optimum for the nursing young. R. R. Huestis' studies on more than 500 Peromyscus showed that pelage coloration varied directly with the arid habitat. The cerebellum in amphibians, studied by O. Larsell, has reached maximum development in land-living Anura, remaining poorly developed in more primitive urodeles. J. E. Guberlet, V. J. Samson and W. H. Brown showed that yolk-sac dropsy in fish is due to the bacterium *Diplobacillus liquefacius piscium*, being experimentally induced in 75 per cent. of fish exposed. Rosalind Wulzen found that the harmful effects of egg white and liver pulp in planarian nutrition varies with the ratio of these foods. Alice M. Bahrs reported that growth-promoting power of rabbit digestive mucosa for Planaria diminishes when mucosa of fasted or of old rabbits is provided. H. S. Warren announced the discovery of a new cestode parasite in *Artemia salinas*, in the cysticercoid stage. Papers by invitation were presented Friday forenoon. E. Gellhorn showed that in sea urchin eggs, at a constant pH, the permeability of dyestuffs is decreased by Ca and

increased by Mg and Na. The increase due to Na and Mg may be suppressed by Ca. These changes do not inhibit fertilization and cleavage. J. Murray Luck, Grace Sheets and J. O. Thomas reported the successful culture of the ciliate Euplotes on two strains of bacteria in a basal medium of artificial sea water and glucose. An inoculum of about 20 individuals flourished while that of one or two individuals died off. They described a method of rendering Euplotes free of bacteria, but this ciliate could not be reared under aseptic conditions on dead bacteria, bacterial autolysates, blood sera or simple organic nutrients. E. Victor Smith showed that the age and growth-rate of the starry flounder, *Platichthus stellatus,* can be accurately determined by the number of annular rings on the otoliths. The method was successfully checked by size frequency groupings. Quinn McNamar and Calvin P. Stone found that memory in the white rat varies greatly with individuals and that the rate of forgetting may not be a linear function of time, as determined by maze experiments. Correlation coefficients between learning and relearning scores range from minus 0.06 to plus 0.89 with a weighted average of plus 0.66. Officers elected for the ensuing year are: *president,* D. R. Hoagland; *vice-president,* J. P. Baumberger; *secretary-treasurer,* E. G. Moberg.

WESTERN SOCIETY OF SOIL SCIENCE

(*Report by J. C. Martin, Secretary*)

Four half-day sessions of the society were held at Oregon State Agricultural College with an average attendance of thirty members. A. S. King reported on studies of the percolation of water through typical water-bearing materials in a tank as affected by different types of well casing perforations. M. R. Lewis discussed the development of ground water, pointing out the distinct advantage of deep wells due to the storage capacity of the underground strata. H. P. Magnuson and J. C. Marr reported the results of infiltration measurements on very impervious alkali soils in cylinders in the field as affected by H_2SO_4, gypsum, $CaCl_2$ and $FeSO_4$. W. L. Powers reported good progress in replacing exchange Na with Ca and in restoring permeability and productiveness by use of sulfur and manure in reclaiming black alkali land at Vale Experiment Field. Three papers of the afternoon session of June 16 dealt with the nitrogen and organic matter phases of soil investigations; H. F. Holtz, working with Palouse soil, reported that when plant residues are below 2 per cent. there is insufficient N for active decomposition and other sources of N must be depended upon for accumulation of NO_3-N in the soil; W. L. Powers and R. D. Lewis reported an increased NO_3 supplying power accompanying increases in total N and organic C during five three-year rotations, resulting in marked increases in yield of crops; M. M. Oveson showed changes in N and organic matter content of two soil types by the growth of Austrian winter peas, changes in the organic matter content correlate with those of N content where the peas were either harvested or returned to the soil. The first three papers of the morning session of June 17 pertained to studies of soil phosphate; P. L. Hibbard pointed out the desirability, in making equilibrium extracts, of having the pH the same for all soils and of using a highly buffered acid, as acetic, for the extraction; C. V. Ruzek reported that the "blue colorimetric" method for phosphate, as modified by Truog, offers possibilities for field recommendations based on laboratory investigations; R. E. Stevenson and H. D. Chapman reported on a study of eleven soil series receiving from one to twenty-two annual applications of phosphate fertilizer showing that in light to medium textured soils appreciable penetration into the root zone of plants occurred while in very heavy soils there was little or no penetration. E. L. Proebsting found that in a series of field plots of fine sand, growing Tuscan peaches, applications of KCl since 1926 which have trebled the replaceable K in the top foot have not affected the K content in the lower depths; the ash of the twigs shows increased K. J. S. Jones pointed out certain possible relations between the physical and chemical characteristics of some orchard soils with the quality of the Bosc pears produced. S. C. Vandecaveye reported that the addition of medium decomposed manure to virgin peat, of low available P and Ca and of reaction pH 4.3, stimulated microbiological activities as measured by CO_2 evolution and caused an appreciable increase in numbers of fungi, whereas the addition of superphosphate (600 lbs. per acre) was without effect. R. E. Bell found from studies of fertilizer applications to six soils in pot experiments that various types of plants give different responses. L. Doneen reported investigations of the NO_3-N absorption by eleven varieties of winter wheat on different soil treatments; some varieties show quite marked differences in rates of absorption as compared to others. The abstract of a paper by G. B. Bodman and E. P. Perry was read in which was discussed the significance of various single value expressions as indicators of physical characteristics of soils. W. Macfarland presented a paper dealing with the relation of the fertilizer industry to the scientific associations, and J. F. Breazeale read a very interesting paper on the development and maintenance of a high standard in agricultural research.

OBITUARY

RECENT DEATHS

DR. H. KARL WILLIAM KUMM, African explorer and geographer and former managing director of the Board for Medical Education and Research in Africa, died in California on August 23 at the age of fifty-six years.

MR. WASHINGTON B. LEWIS, assistant director of the National Park Service and formerly superintendent of Yosemite National Park, died recently in California at the age of forty-six years.

PROFESSOR CONRAD E. LINDBERG, since 1920 dean of Augustana Theological Seminary, Rock Island, Illinois, died on August 2.

DR. E. ALBERTA READ, assistant chief of the micro-analytical laboratory of the bureau of chemistry, Department of Agriculture, died on September 1.

THE death by suicide is announced of Dr. Emory G. Alexander, Philadelphia surgeon, assistant professor of surgery at the University of Pennsylvania and a major in the Medical Reserve Corps of the United States Army.

DR. JOHN ELDER MACILWAINE, formerly professor of materia medica and therapeutics at Queen's University, has died at the age of fifty-six years.

AFTER a short illness, Geheimrat Prof. Dr. Theodor Axenfeld, director of the university eye clinic in Freiburg im Breisgau, and for many years editor of the *Klinische Monatsblätter für Augenheilkunde*, died on July 29 at the age of 63.

MEMORIALS

THE *British Medical Journal* reports that on July 13 a tablet in memory of Sir William Osler was unveiled at Ewelme Church by the Bishop of Oxford. As Regius professor of medicine in the University of Oxford, Osler was Master of the Ewelme Almshouse, and whenever he could find time he loved to visit this secluded and picturesque spot. He had its mouldy old records cleaned, bound and preserved in a fire-proof safe in the muniment room. The tablet commemorates also Lady Osler and their son Revere.

A MEMORIAL to Drs. B. N. Peach and John Horne was unveiled at Inchnadamph, in the wilds of the northwestern highlands of Scotland, by Sir John Flett on July 25. Mr. H. M. Cadell, of Grange, presided over the company, which included many well-known Scottish scientific workers. In dedicating the memorial, Sir John Flett described its site as properly selected in the center of a remarkable area to which the discoveries and interpretations of Peach and Horne had given world-wide fame, a temple of geology to which geologists from all parts of the earth made pilgrimage. He paid a warm tribute to the work of his friends, to their spirit of cooperation and goodwill, and to the single-mindedness of their scientific endeavors. The memorial, a massive pillar of stone set on a height overlooking Loch Assynt, carries a bronze tablet with the inscription: "To Ben N. Peach and John Horne, who played the foremost part in unravelling the geological structure of the North-West Highlands, 1883–1897: An international tribute. Erected 1930."

SCIENTIFIC EVENTS

THE BEIT MEMORIAL FELLOWSHIPS

SIR JAMES K. FOWLER, trustee and honorary secretary of the Beit memorial fellowships for medical research, has issued his annual report in which he reviews the work of the foundation since its establishment in December, 1909.

Sir Otto Beit's gift of £230,000 was of a magnitude that had no precedent in English medicine and the annual income derived therefrom has ever since been applied to the endowment of men and women, and none of it has been spent upon the erection of buildings. In its first year the trust created ten new fellowships, and within three years there were thirty fellows engaged in medical research, the openings to which were thus increased almost threefold.

In the earlier years the value of a fellowship was £250 per annum, and the tenure three years, with a possible extension to a fourth year in cases where marked distinction had been shown. In 1922, to meet the objection that three, or possibly four, years was too short a time to enable a man to give such evidence of capacity for research as would be likely to attract attention and thus to open up a prospect of a career, the fellowships were reorganized providing for seven years of continuous research.

The values of the fellowships were then fixed at junior fellows, £350 per annum; fourth year, £400, and senior, £500. In 1927 the stipends were again revised and increased to £400, £500 and £700, respectively; at these values they have since remained.

In 1927 a senior fellowship, value £1,000 per annum for five years for research in tropical medicine, was created. To this Dr. Edward Hindle was appointed. This research has already afforded an answer to several questions of great practical importance in connection with yellow fever. It has been shown that:

(1) A vaccine prepared from the organs of monkeys of a certain species infected with the virus of yellow fever will give protection to other animals of the same species.

(2) That animals thus protected can withstand a dose of the virus a million times as great as that which is fatal to the unprotected.

(3) That, although this vaccine prepared from monkeys is protective to monkeys, it has not yet proved possible by similar methods to immunize human beings.

(4) That Europeans may suffer from a mild disease not clinically recognizable as yellow fever, and that subsequent examination of their blood may prove that all the accepted tests of immunity are present.

In view of the dangers of this work, the trustees have decided not to continue the research under present conditions.

Excluding those whose appointments are of too recent date to justify their inclusion, and taking the year 1925 as a convenient limit, it appears that the total number of fellows elected up to then was one hundred and one, of whom seventy-nine were men and twenty-two women; of the men seven died at a relatively early age, but none of the women.

Considering first the careers of the seventy-two men, it appears that four have received the F.R.S., the greatest distinction in science, and sixteen have been appointed to university professorships, a high proportion considering that the group includes many who are still young. Most of the remainder occupy whole-time posts for teaching, research or scientific work and have steadily continued the career upon which many entered when first elected to a Beit fellowship.

Of the total of fifty-two who held medical qualifications when appointed, thirteen have passed into medical practice, consulting or otherwise, but the majority of these are continuing scientific work and are thus influencing the character of the art in which they are now engaged.

Of the twenty-two women a few have married, but all continued for many years the work of research and many are still thus engaged. That they hold, or have held, such positions as members of the scientific staff of the Lister Institute, university lectureships in biochemistry; pathologist and bacteriologist to general hospitals and boards of health; head of a department in an institute for medical research; principal of a horticultural college; physicians to children's hospitals, and holders of Rockefeller medical fellowships is noteworthy.

Thomas Lewis and Edward Mellanby are especially mentioned as being appointed at the first election in 1909. During the last fifteen years England has made no more conspicuous contributions to the knowledge that guides practical medicine than those which lie in the analysis of disorders of the heart by Sir Thomas Lewis, and in the experimental proof that rickets is due to vitamin deficiency by Professor Edward Mellanby.

THE MUSEUM OF THE CITY OF NEW YORK

THE Museum of the City of New York, which will open some time this fall in the buildings now being erected at Fifth Avenue and 103d and 104th Streets, has received a gift of $50,000 for the installation of a gallery illustrating the development of communication in greater New York, as announced by Hardinge Scholle, director of the museum, in *The New York Times.*

The donation, which is part of the original budget for the building fund of $1,600,000, was contributed jointly by the leading national communication systems. The companies which made the new establishment possible are the American Telephone and Telegraph Company, and its subsidiaries, the New York Telephone Company, the Western Electric Company, Inc., and the Bell Telephone Laboratories, Inc.; the International Telephone and Telegraph Corporation, and its subsidiaries, the Postal Telegraph Company and the Commercial Cable Company; the National Broadcasting Company, and the Radio Corporation of America.

The gallery will be used to demonstrate the development of intelligence communication, from a historical point of view, and only in so far as the use of new methods and inventions have affected the city's progress. There will be ten exhibition groups, designed by artists for miniature illustrations of the various stages of development and between the exhibition groups there will be exhibit cases, supplementing the scenes portrayed with prints, photographs and specimens of the instruments and models used in each stage of mechanical evolution.

Plans formulated by the officials of the museum, which are as yet somewhat tentative, provide for sets depicting the following scenes:

(1) Primitive communication: Early eighteenth century scene before a Dutch tavern, with the town crier ringing a bell in the village square.

(2) Harbor semaphore, about 1770: Scene on Fort Wadsworth Hill, S. I., showing semaphore attached to a

large pole signaling to ships in the lower bay and to Manhattan.

(3) Marine cable: Night scene showing Samuel Morse laying the first cable from Castle Garden to Governors Island in 1842.

(4) Scene showing the first stock ticker in the office of Joseph Grosbeck & Co., in 1867, initiating the elimination of ''runners'' in stock quotations.

(5) Alexander Graham Bell demonstrating the telephone at Chickering Hall in 1876.

(6) Modern developments in the postoffice and mail service.

(7) Overhead telephone and telegraph wires in the blizzard of 1888.

(8) Mechanism of the modern telephone.

(9) Mechanism of wireless telegraphy.

(10) Tentative modern scene—perhaps the Democratic Convention of 1924 showing the employment of all methods of communication, such as the telephone, telegraph, radio, street amplifiers and the telegraphic transmission of photography.

THE NEW WALL MAP OF THE UNITED STATES

A WALL map of the United States which will be designated as official for use of the Federal Government has been compiled by the Geological Survey and is now approaching completion, according to a review of map-making activities prepared by the senior mathematician of the Coast and Geodetic Survey, Oscar S. Adams, as reported in the *U. S. Daily*. The work of engraving the map will be completed in approximately six months, it was stated orally on August 19 on behalf of the Geological Survey.

The map is on a scale of one part in 2,500,000, on the Albers equal-area projection with two standard parallels. The extent of the United States is such as to be well fitted for mapping on a conical projection with two standard parallels, and the equal-area property is of great value in some uses for which the map may be required, according to Mr. Adams' review, which covers map-making activities during the years 1927, 1928 and 1929. "Since there are always two directions at every point that have true length scale, this kind of a map is about as satisfactory as any for scaling approximate distances between places," according to the review, which is as follows:

During the period of the past three years interest in map construction and map projections has continued to exist even in a greater degree than formerly. The need for special maps for aerial navigation has tended to this end. In general, two types of projection are considered for these maps, either the conformal or the equal-area projection.

The Coast and Geodetic Survey has published two pamphlets dealing directly with projections and has also issued a revised edition of another projection publication during this period. Some time ago the Board of Surveys and Maps of the Federal Government adopted the Albers projection for the general map of the United States.

Since no table of coordinates for such a map had been computed, a table was prepared at the request of the Geological Survey and published as Special Publication No. 130 under the title ''Tables for Albers Projection.'' In Special Publication No. 153 is contained a development and computation of a conformal projection of the sphere within a square. One of the important contributions of the Coast and Geodetic Survey to this branch of geodetic work is Special Publication No. 68, ''Elements of Map Projection with Applications to Map and Chart Construction.'' A revised edition of this work was issued in 1928.

In 1929 the Geological Survey published ''Formulas and Tables for the Construction of Polyconic Projections,'' compiled by C. H. Birdseye as Bulletin 809. This publication gives the coordinates in inches for various scales of maps such as are produced in that bureau. Some forty pages of introductory text serve to explain the computation of the tables and their use in the construction of maps.

In the construction of maps for airways the Lambert conformal projection is used by the Coast and Geodetic Survey. The chief work in this line done up to the present time has consisted in the construction of maps for certain aerial mail routes. The work on sectional maps for general flying is just beginning and will be carried on until the whole country is covered by maps of this kind.

The Bureau of Foreign and Domestic Commerce has had constructed an interrupted map of the world on the sinusoidal equal-area projection which that bureau finds of great use in statistical work. This type of projection is certainly to be preferred in all cases where the relative area of various sections of the map come into consideration. Another equal-area world map has been constructed by S. W. Boggs, of the State Department, that is found to be very useful in certain statistical work of that department. It is coming to be recognized more and more that in the construction of a given map a projection should be chosen that will be best suited to the purpose in view.

A wall map of the United States, scale 1 part in 2,500,000, on the Albers equal-area projection with two standard parallels, has been compiled by the Geological Survey and is practically ready for engraving. After completion this map will be the official wall map for this country and should soon supersede all other types of wall maps in use in the various governmental departments. The extent of the United States is such as to be well fitted for mapping on a conical projection with two standard parallels, and the equal-area property is of great value in some uses for which the map may be required. Since there are always two directions at every point that have true length scale, this kind of a map is about as satisfactory as any for scaling approximate distances between places.

Some of the large radio broadcasting stations have found special use for the azimuthal equidistant projection with the station placed at the center of the projection. Such a map gives at once the azimuth and distance of any other point from the broadcasting station. Of course a separate map has to be prepared for each station, and this requires a considerable amount of computation and compilation if an accurate map is to be produced.

THE CONFERENCE OF AGRICULTURAL STATES OF EASTERN EUROPE

WE learn from the New York *Sun* that representatives of the agricultural states of eastern Europe have been meeting in an agricultural conference at Warsaw.

The delegates were able to form an "entente cordiale" of eight agricultural states—Poland, Roumania, Czechoslovakia, Jugoslavia, Hungary, Bulgaria, Latvia and Estonia. Lithuania declined an invitation to attend the conference for political reasons.

The League of Nations will be asked to work out an international convention prohibiting export bounties for agricultural products. Special measures will be taken to eliminate ruinous competition among the agricultural states and also to adapt their exports to the requirements of importing countries.

One important decision was the adoption of a "preferential clause" applicable by European countries importing agricultural products to those producing them, in order to protect Europe against a flood of American cereals. It was also decided to hold periodical meetings of the agricultural entente states.

Poland took the initiative in convening the meeting. This country has already signed with Germany the "rye convention" with a view to putting an end to ruinous competition in the Scandinavian markets, which Poland could have conquered because her labor costs are far lower than Germany's. Poland also has done much towards the rationalization of exports of live stock and by-products of the industry.

SCIENTIFIC NOTES AND NEWS

THE Royal Society of Natural History of Madrid has added Professor W. M. Davis, of Harvard University, to its list of honorary members. Professor Davis has spent the summer at Eugene, Oregon, where he has given two courses of lectures at the summer session of the state university.

DR. ROSS G. HARRISON, Sterling professor of biology at Yale University, has been elected a corresponding member of the Prussian Academy of Sciences in Berlin.

PROFESSOR L. R. JONES, of the department of plant pathology of the University of Wisconsin, has received an honorary degree of doctor of science from Oxford University. He attended the fifth international botanical congress at Oxford University in August.

AT the recent convocation of the University of California, the degree of Ph.D. was conferred on J. A. Pearce, of the Dominion Astrophysical Observatory at Victoria, B. C., Canada.

WE learn from the *Journal* of the American Medical Association that Dr. Harry J. Corper, of Denver, has been awarded the Ward Burdick Research gold medal by the American Society of Clinical Pathologists for his work in isolating and culturing the tubercle bacillus. Dr. Rodney H. Jones and Dr. Edward R. Mugrage, instructor and professor in clinical pathology, respectively, at the school of medicine of the University of Colorado, were awarded a gold medal for the best scientific exhibit presented at the annual meeting of the American Society of Clinical Pathologists which was held at Detroit recently. The exhibit concerned the Aschheim-Zondek pregnancy test.

AT the one hundred and fifth annual exhibition of the National Academy of Design, an ibex bronze by James L. Clark, assistant director in charge of preparation at the American Museum, was awarded the Speyer Memorial Prize for animal sculpture.

THE Planck gold medal has been awarded to Dr. Niels Bohr, professor of physics at the University of Copenhagen.

THE Osler memorial medal for 1930 has been awarded to Sir Wilmot P. Herringham. This bronze medal is awarded every five years to the Oxford medical graduate who has, in the opinion of the board of awarders, made the most valuable contribution to the science, art or literature of medicine.

THE governing body of Corpus Christi College of the University of Cambridge has made the first award of the Copeman medal for research in medical and biologic sciences to Dr. Reginald Hilton.

DR. N. L. BRITTON, who recently retired as director of the New York Botanical Garden, has been elected honorary president of the International Desert Conservation League, an association recently organized in California "to respond to an urgent demand for the protection of desert plant life and the conservation of desert beauty spots in the form of park areas containing rare desert flora and fauna."

DR. G. CARL HUBER, dean of the graduate school of the University of Michigan, has been elected president of the Alumni Association.

HOFRAT ERNST FUCHS, professor of ophthalmology at Vienna, has been elected an honorary member of the Japanese Ophthalmological Society.

DR. KARL SUDHOFF, formerly professor of the history of medicine at Leipzig, has been elected a foreign member of the Hungarian Academy of Sciences at Budapest.

IT is stated in *Nature* that in honor of the seventy-fifth birthday of Professor Bohuslav Brauner, of the University of Prague, a special jubilee number (May–June) of the *Collection of Czechoslovak Chemical Communications* has been issued. This number contains more than twenty original contributions by friends and pupils of Professor Brauner, together with a complete bibliography of his own original works and an account of his association with D. I. Mendeléeff.

DR. HENRY MCELDERRY KNOWER has been appointed associate professor of anatomy in the Albany Medical College, Union University.

DR. LEONARD FRANKLIN FULLER, vice-president of the Federal Telegraph Company, has been made head of the electrical engineering department at the University of California.

DR. CHARLOTTE GOWER has been appointed assistant professor of physical anthropology at the University of Wisconsin.

THEODORE DREIER, formerly an electrical engineer at the General Electric Company in Schenectady, N. Y., has been appointed assistant professor of physics at Rollins College for the coming year. He will fill the position previously held by Dr. William S. Franklin, who died last June.

DR. SAMUEL A. STAUFFER has been appointed assistant professor of social statistics at the University of Wisconsin. He will spend half of his time at the University of Chicago.

DR. HENRY DRYERRE has been appointed physiological biochemist to the Animal Diseases Research Institute at Moredun, Edinburgh. For about ten years Dr. Dryerre has been lecturer in physiology at Edinburgh University and professor of physiology at the Royal (Dick) Veterinary College, a post which he is retaining. Mr. W. S. Gordon has been appointed senior bacteriologist to the same institution. He has been working for some years at the Wellcome Research Laboratories.

PROFESSOR AUGUSTO BONAZZI has accepted a position as director of the Estación Experimental Agronómica, located at Santiago de las Vegas, Habana, Cuba.

THE council of the University of Leeds has elected Dr. Frederick Challenger to the chair of organic chemistry, shortly to be vacated by Professor Ingold. Dr. Challenger is at present senior lecturer in chemistry in the University of Manchester.

DR. GEORGE H. HART, head of the division of animal husbandry at the Agricultural Experiment Station of the University of California, has been granted six months' leave of absence for study in Europe, partly on mineral metabolism in livestock and deficiency troubles resulting from insufficient intake of mineral elements and vitamins at the Rowett Research Institute. Dr. F. M. Hayes, associate professor of veterinary science and veterinarian, has been granted leave for the same period and will spend approximately three months in a study of contagious abortion at the University of Giessen.

DR. D. ROBERTS HARPER, 3D, has resigned as consulting thermal engineer to the General Electric Company and as associate professor of physics at Union College, to become a member of the staff of the newly organized coal research laboratory at the Carnegie Institute of Technology.

DR. A. F. WOODS, director of scientific work for the U. S. Department of Agriculture, has been appointed head of the delegation which will represent the United States at the Inter-American Conference on Agriculture, Forestry and Animal Industry to be held in Washington, D. C., from September 8 to 20. All the Latin-American governments are expected to be represented at the conference. Other members of the American delegation are Dr. B. T. Galloway, Leon M. Estabrook, Dr. William A. Taylor, Dr. Nils A. Olsen and Dr. John R. Mohler, all of the Department of Agriculture; George M. Rommell, industrial commissioner of Georgia; Dr. William Crocker, director of the Boyce Thompson Institute for Plant Research; Dr. Carlos B. Chardon, commissioner of agriculture, of Porto Rico; Dr. Carl A. Alsberg, of Stanford University, and Dr. Robert A. Harper, of Columbia University.

MISS FRANCESCA LA MONTE, assistant curator of ichthyology in the American Museum of Natural History, has been appointed official delegate from the museum to the Eleventh International Congress of Zoology, to be held this month in Padua, Italy.

DR. HANS ZINSSER will deliver the Carpenter lecture before the New York Academy of Medicine on Oc-

tober 29 at 8:30 P. M. The subject of the lecture will be "Immunity—General and Local."

THE fifteenth annual meeting of the Optical Society of America will be held at the University of Virginia, Charlottesville, Virginia, from October 30 to November 1.

DURING the centenary of the independence of Uruguay, an International Congress of Biology will be held in Montevideo, from October 8 to 12, the first of the kind to be held in South America. The chairman of the committee on organization is Professor Clemente Estable. The committees in Argentina (*Chairman,* Professor B. A. Houssay), Brazil (*Chairman,* Professor M. Ozorio de Almeida), Chile (*Chairman,* Dr. Eugenio Suarez) and other countries will cooperate to make the congress a success. The central committee and the committee of Argentina have invited a number of eminent men in Europe and the United States to assist at the congress, and the following men have accepted the invitation: Professors McClung, United States; Brachet, Belgium; Rondoni, Milan, and Embden, Frankfort. The congress is to be held under the auspices of the Sociedad de Biología de Montevideo.

THE German Neurological Society will hold its annual meeting at Dresden on September 18. The principal subject for discussion will be the theory and practice of the problem of resistance in nervous diseases, introduced by Drs. Boeke, of Utrecht; Spatz, of Munich; Foerster, of Breslau, and Goldstein, of Berlin.

UNDER the will of Leon Schinasi, tobacco merchant and president of the Schinasi Commercial Corporation, $50,000 is bequeathed to the Sydenham Hospital, of which he was a director.

THE United States Civil Service Commission states that the position of principal chemical engineer, Nonmetallic Minerals Experiment Station, Bureau of Mines, Department of Commerce, New Brunswick, N. J., is vacant. Instead of the usual form of civil-service examination, the qualification of candidates will be passed upon by a special board of examiners, composed of A. C. Fieldner, chief engineer, experiment stations division, Bureau of Mines; F. G. Cottrell, chief of the Fixed Nitrogen Research Laboratory, Department of Agriculture; and A. S. Ernest, examiner of the United States Civil Service Commission, who will act as chairman of the committee. The minimum qualifications for consideration are scholarship equivalent to that represented by a Ph.D. or Sc.D. degree from a college or university of recognized standing, with major work in chemical engineering or physical chemistry. The duties of the position are to direct the work of the Nonmetallic Minerals Experiment Station of the Bureau of Mines at New Brunswick, N. J. The entrance salary is $5,600 a year. Promotion may be made without change in assignment up to $6,400. Applications should be sent to the U. S. Civil Service Commission, Washington, D. C., for Form 2600, which should be filed in the office of the U. S. Civil Service Commission, Washington, D. C., not later than October 1, 1930.

BY the will of Mrs. Alice Harrington Santher the St. Vincent's Hospital of New York will receive $22,500. The Ellin Prince Speyer Hospital for animals will receive $25,000.

THROUGH the interest of the Western Air Express and the Richfield Oil Company, two chairs of aviation education are being established at the University of Southern California. The Harris M. Hanshue Chair of commercial aviation, endowed by the Western Air Express and named for its president, will be filled by Earl W. Hill, lecturer in the college of commerce and business administration of the university. The James A. Talbot Chair of aeronautical engineering, endowed by the Richfield Oil Company and named for the chairman of its board of directors, will be filled by James M. Shoemaker, an aeronautical engineer and newly appointed professor in the college of engineering, assisted by Captain Douglas Keeney.

THE Union of Socialist Soviet Republics is organizing the study of geographical, hydrological and meteorological features under the direction of a newly formed hydrometeorological department. It will have functions similar to those of the U. S. Weather Bureau in the gathering and disseminating of weather information, and the making of meteorological and hydrological reports and forecasts for the aid of aviators, farmers, navigators and others who depend on accurate predictions of weather. It will also study terrestrial magnetism. A district system, with local stations and observatories, is being organized to work on the varied local conditions and problems, for the area of Russia is so great as to include semi-tropical climate as well as polar ice and snow fields. Each of the republics has its own hydrometeorological committee, and they all report to the main U.S.S.R. hydrometeorological committee, of which Professor Vangenheim is the new president.

A new evening course for graduate electrical engineers, which is to be conducted jointly by the Moore School of Electrical Engineering and the Wharton School of Finance and Commerce, will be given by the University of Pennsylvania.

DR. FRANK AYDELOTTE, president of Swarthmore College, and Eyler Simpson, both representatives of

the Guggenheim Foundation, returned from an eleven weeks' tour of South America on September 6. Dr. Aydelotte and Mr. Simpson went to establish Guggenheim scholarships in Argentina and Chile. The scholarships will allow $2,500 yearly and traveling expenses.

THE University of Wyoming summer school in geology (which is situated in the Medicine Bow Mountains, forty miles from Laramie) on July 26 closed a successful five weeks of field instruction in the geology of the Rocky Mountain Region of Wyoming and Colorado. Forty students, of whom thirty-three were engaged in the advanced course, attended the camp. During part of the summer Dr. H. de Terra, of Berlin, exchange professor of geology at Yale, was a guest of the camp, while regular instruction was provided by Dr. S. H. Knight, director, and Dr. R. H. Beckwith, of Wyoming, and Dr. H. S. Sharp and Mr. W. H. Thomas, of Columbia University.

ACCORDING to Science Service, Death Valley, in southeastern California, may become the newest addition to the lands administered by the U. S. National Park Service. President Hoover has signed an executive order temporarily reserving from entry certain strategic points in and about the valley, pending investigation by the Department of the Interior of its suitability for a national monument. National monuments differ from national parks in that they are usually less developed and less visited, and hence require less elaborate administration and patrolling. A national monument may become a national park when public interest in the area becomes great enough to justify a larger outlay of administrative effort and funds. Many of the present national parks passed through a national monument phase. If Death Valley becomes a part of the U. S. National Park system, it will be an appropriate monument in more senses than one. The late Stephen T. Mather, first director of the U. S. National Park Service, at one time had extensive business interests in the borax deposits of the region, and the present director, Horace M. Albright, was born at Bishop, Calif., on the very threshold of the valley.

DISCUSSION

NOMENCLATURE AND ME

CONCERNING the technique of the naming of animals and plants, Professor Needham has recently[1] pointed out some of the vices of the system, and suggests, as a remedy, a secondary or skeletal system based on and superposed on the expanded Linnean. This secondary system, he admits, would not remedy the vices of the primary. As a morphobiologist I would prefer one system to two. Our real problem is to obviate the exercise of vicious practices on the part of some (let us be fair) systematists. Needham quotes Darwin, who cleverly places his finger on the root of all evil (as did "the Preacher" before him), namely: vanity.

Abstractly, the scientist (and unfortunately, this includes some tyro collection makers) should be impersonal, detached, disinterested. Actually he is a normal, usually quite human being, often with as much of a taint of egoism as others of his species. Our rules and regulations are based on the abstract concept. The result is the humanization of nomenclature. The rules have been taken advantage of by some, and it is just these few that spoil Professor Needham's teaching efficiency.

As a resident afar, dwelling where there are no proper library facilities for checking up on usable generic names, I have reason to know that it is a temptation to make up unimaginable generic and specific names. It is not due to priority (let us be discriminating) that such names are invented, but due to the fact that one's own name may (it always does!) appear after the scientific name if the latter is a new one. Were the "authority" never seen in print, or hardly ever, the temptation would be negligible enough to be counteracted by other considerations.

Another bit of technique is to leave a new genus or species clearly indicated but not named, in the hope that a later worker may name it after its "indicator." Similarly, an author may name a genus or species like a preceding (and "neglect" to rename it although his attention is called to the synonym), trusting that after his death some one will rename it after him. This might be avoided by a rule to the effect that genera and species may not bear the name of a worker. His work (and name in the bibliography) should be enough of a memorial or reward to his ego—and judging from the bewildering number of milestones bearing the same name, along the bibliographic highway, it is evident that some workers are doing themselves credit. One institution has gone so far as to gather together all the bricks stamped with the same name to erect pyramids among their scientific monuments.

(On the other hand, the name of collectors may be used, as a just reward for the hardships some of them

[1] SCIENCE, n. s., 71: 26–28, January 10, 1930.

must endure and as an encouragement to careful and thorough collecting. This would be the only exception to the worker-name rule, but it should be done only as a reward of real merit.)

The problem, then, is to eliminate vanity. There is no simpler way to bring this about than to outlaw the quotation of the author after a generic, specific, subspecific, varietal or mutational name. As a systematist, who has the privilege of inscribing his name after I do not know how many such scientific names, I would suggest to the International Committee on Zoological Nomenclature that they adopt a rule to the effect that the author's name shall appear only in synonymic catalogues or papers of rectification. Unfortunately for the adoption of radical ideas, the International Committee is composed, for the most part, of elderly systematists. If Professor Needham sees reason in the present suggestions, will he join me in the anti-authority crusade by omitting all authorities in his papers and encouraging others to do likewise? Editors should then be encouraged to drop from submitted manuscripts all scientific name authorities.

Some one will immediately raise objection on the grounds that one will be unable to tell to which of two species a paper refers: as *B. lata* of Smith (from England) or *B. lata* of Wang from China, at first thought to be identical, later found to be distinct. Such difficulties can always be raised by die-hards, but the intelligent, adaptable scientist is able to find a solution. In this particular example, as is well known to all taxonomists, *B. lata* Wang is renamed (not *B. wangi*), and ever after *B. lata* Wang needs not be referred to again, except in a catalogue of synonyms.

Here then we come to the morgue. Every family of plants and animals, on account of still-births, illegitimates and other anomalous and useless offspring of hasty or ignoble taxonomists, should have a synonymic catalogue for the reception of its useless progeny. To this catalogue all vain systematists may turn to count up their dead offspring or check up on the parent of legitimate, well-born children. Further, in a comprehensive systematic paper or report, it would be legitimate to quote the original description and two or three cardinal synonyms (as is done anyway), in six-point type, under the authorityless specific name. But why place the authority after the name and then in the synonymy or literary reference immediately beneath, except to gratify one's sense of vanity?

Coldly considered there is perhaps no more illogical procedure in our scientific nomenclature than this author notation. For usually on turning to the author's work, instead of finding a detailed description, a detailed set of figures and comparative data, one finds a few lines in Latin which might fit one of many species, or a fairly long description which dodges the differential characters. Far more valuable would be a reference to a monograph embodying enough data for ready identification or a figure which will give the reader a clear concept of the species in question without much expenditure of time. The old system undoubtedly had its place, but is it not time to break an old habit and adapt ourselves to a more rational, practical and less dangerous technique?

As a transitional step, after each scientific name one might place a numeral which refers to the paper of original description in the bibliography. And right here we come upon another of science's mooted points,[2] namely, what system of bibliographic reference shall be used, the numerical or egocentral? As scientists (impersonal beings) we can only use the numerical. Would this not tend to discourage the writing of too many papers? At least it would help to eliminate the personal element from our scientific contributions.

I fully sympathize with Professor Needham in his desire to simplify scientific nomenclature for the student, but to have to later introduce an advanced student to a vicious "fundamental" system of nomenclature is hardly satisfactory, while to remove the spice of vanity from the hyperconsciousness of some "scientists" would be striking at the root of the evil, with a little kick.

Perhaps there is no more vicious system than that of the botanist where two authorities appear or, worse yet, where the only authority is that of the upsetter of stability. As at present practiced, the authority of a plant name is not (or rarely) the original describer, but he who can, by any stretch of the systematists' art, place the species (or lower denomination) in a different genus. The result is an enormous increase in generic assignments, chiefly through the erection of new generic names. Thank God this system is foreign to the zoologist!

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A NOTE ON THE LIFE HISTORY OF THE LARGE AMERICAN FLUKE, FASCIOLA MAGNA (BASSI)

IN the course of an investigation of liver flukes in sheep and cattle in the United States, especially as regards the life histories and the intermediate hosts of the flukes, the writer made a survey of the Western and Southern states during the period from the

[2] SCIENCE, n. s., 71: 38–39, January 10, 1930.

spring of 1929 to the spring of 1930. The most favorable area found for the study of the large liver fluke of cattle, *Fasciola magna*, was in the region of the swampy plains of southern Texas, and the writer spent part of the winter at Houston investigating the life history of this parasite. In this study he had the use of a laboratory and other facilities at the Rice Institute through the courtesy of Dr. Asa C. Chandler, of the institute faculty. The results of the investigation on the life history of *F. magna* may be summarized as follows.

F. magna, unlike *F. hepatica,* has nothing to do with the bile system of cattle, apparently, as it lives in the liver tissues, or sometimes as an erratic parasite in the lungs, enclosed in the liver in an encapsulated cyst which does not appear to have any connection with the bile ducts. The eggs of *F. magna* were never observed in the bile of a cow infested with that worm, as they would be in the case of *F. hepatica,* but they were found rather abundantly in cases of heavy infestations in the cysts and in the contents of the digestive tract. This suggests that the eggs of *F. magna* may use the blood system for getting out of the infested animal, but positive confirmation of this idea was not obtained.

Neither in size nor shape do the eggs of *F. magna* differ from those of *F. hepatica,* but they are furnished with an appendage, a sort of filament, by which they can be easily identified. Besides this, the eggs of *F. magna* develop much slower than do those of *F. hepatica;* the first miracidia begin to appear on the thirty-third day, while in the case of *F. hepatica,* under the same conditions, miracidia appear on the eleventh day.

The miracidium of *F. magna* is very like that of *F. hepatica,* but it can be distinguished from the latter by the peculiar shape of its head papilla, by the ratio of its body parts and by the size of its germ-cells. In the writer's experiments, the miracidia of *F. magna* readily attacked *Galba bulimoides techella* Hald., in which snails they developed successfully and produced their first generation of rediae. It was necessary to stop the experiments on the forty-fifth day of their development, and the cercariae had not appeared at that time, but the cercaria phase was studied in snails that were infested naturally, and in this case the redia, which differs from that of *F. hepatica,* made it possible to identify the species definitely.

The cercaria of *F. magna* is very much like that of *F. hepatica.* The specific characters by which it can be recognized are its size, about three fifths that of *F. hepatica,* and its excretory system; in *F. magna* the large excretory ducts are not yet fused in this stage to form a common stem or excretory vesicle as in the case of *F. hepatica.* Like the cercaria of *F. hepatica,* it encysts on everything that it happens to come in contact with while swimming around, and the cysts, superficially, do not differ from those of *F. hepatica.*

Galba bulimoides techella Hald. is a very common snail in the area investigated, and is also the only limnaeid species that is widely distributed there. It keeps to the muddy borders of ditches, pools or other collections of water, all of which are abundant in that part of Texas.

It is worth mention, in this connection, that *Galba bulimoides techella,* as was proved experimentally,[1] is also the intermediate host for the common liver fluke, *F. hepatica,* which is widely distributed through the Southern states. As for the Western states, where, save for the southern part of California, *Galba bulimoides techella* is absent, another snail, *Galba bulimoides* Lea, appears to be responsible for the spread of liver fluke disease, as was experimentally proved by Simms and Shaw for Oregon and by the writer for California.

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[1] *Jour. of Parasitology,* October 20, 1928.

SCIENTIFIC BOOKS

Plant Hybridization Before Mendel. By H. F. ROBERTS, the University of Manitoba. Princeton University Press. $4.

THE growing recognition of the importance of hybridism in the breeding of plants and animals and in the races of men should receive a further impetus from the publication of this well-balanced, adequate and extraordinarily interesting book. The only inadequacy noted is in the title, for it would be difficult to find anywhere also such an excellent account (the reviewer knows of none) of the events and personalities connected with the recovery of Mendel's long unrecognized work, and the launching of that Mendelism which has so richly transformed biology and also the associated -ologies during the elapsed thirty years of our auspicious century.

The discussion begins with the earliest known cases of the cross fertilization of plants by hand, in the culture of dates, in that region wherein had been

located the traditional "Garden of Eden," and proceeds with commensurate accounts of the results of German, English, French and other hybridizers, until 1902. The author's ability to translate the several languages—he is an accomplished linguist—immeasurably facilitated his thorough search of the literature, which extended over several years and through many libraries in a number of countries. Many of the pertinent facts are stated in lucid translations from, or if in English in, the actual words of the hybridizers themselves. These quotations are introduced with an adroitness and smoothness that would do credit even to the literati.

As already indicated, the work greatly transcends its title in giving a succinct account, probably the best extant, of the rediscovery in 1900 of Mendel's paper, independently by DeVries, Correns and von Tschermak, and the contribution of the late Wm. Bateson in the introduction of Mendelism to the world. The author was aided in the preparation of this account as well as in the production of the rest of the book by a mutually cordial friendship with DeVries, who spent more than two weeks in 1906 in Professor Roberts's home in Manhattan, Kansas, while preparing and revising lectures. The author also spent some time in DeVries's home in Holland. The latter as well as both Correns and von Tschermak have contributed valuable and interesting special letters of personal reminiscences which are included.

The amount of material in the book exceeds the expectations of the only vii + 374 pages, because of the fine, clear print of the extensive though very apposite quotations. This book should go into the hands of all persons interested in either pure or applied biology. The language, including the translated quotations, is such that the general reader may peruse it with facility and keen interest.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE METHOD FOR STAINING SPIROCHETES

THE methods usually employed for the staining of spirochetes in many cases require specially prepared solutions and a mastery of expert technique. A simple, rapid and effective stain based on the method proposed by Kliewe[1] has been used in this laboratory for two years. The solutions are easily prepared in any laboratory and do not deteriorate. The modified method is as follows.

A film of the material to be examined is prepared as usual, air-dried and fixed by passing several times through a Bunsen flame. It is mordanted with a 0.5 to 1 per cent. aqueous solution of potassium permanganate, washed in water, stained with a 2 per cent. aqueous solution of methyl violet and finally washed in water. The time allowed for the action of the mordant is from eight to ten minutes, while the stain is permitted to act for the same period. In staining *Treponema pallidum* it is often desirable to warm the mordant gently on the slide. It is never necessary to warm the stain. For the coarser more easily stained spirochetes a shorter staining time is required, two to three minutes being quite sufficient. The longer period is preferred for the more delicate organisms. With this method the spirochetes are stained bluish-black and the delicate forms stand out clearly. There is a marked contrast on the slide, and the organisms stained by this method have been photographed without difficulty. Good stained specimens have been obtained of various spirochetes, including *Treponema pallidum, Spironema novyi, Spironema obermeieri, Spironema duttoni, Leptospira icterohemmorhagiae, Treponema vincenti,* water leptospira and spirochetes from birds.

[1] *Centralbl. f. Bakt.*, 1924, Ref. 76, 232.

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ARCUATE MOUNTAINS PRODUCED BY MODIFICATION OF STONE'S STRUCTURE MACHINE

THE machine described by Stone, in the accompanying article, lends itself to certain modifications. In addition to its use in producing thrust normal to the face of the thrust block it can easily be modified so as to transmit a thrust by means of a thrust block the face of which may be at any angle to the direction of thrust. This can be accomplished by using an additional board (X) separated from the movable

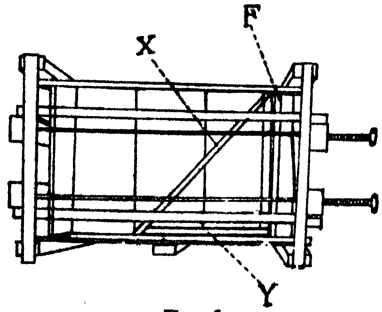


FIG. 1

board (F) by means of a block (Y) of suitable length. By varying the length of the block the angle of the face of the thrust block may be varied. (Fig. 1.)

Chamberlin and Shepard produced arcuate mountains by applying pressure over a limited portion of the free side of a block.[1]

By means of this machine, with the face of the thrust block at an angle of 45° to the direction of thrust, arcuate mountains were repeatedly produced. Fig. 2 shows the results of one of a number of experiments in which such mountains were obtained. The curvature of the fold may be explained by the force resultant of the forces active in its production. This indicates that arcuate mountains can be produced by more than one method.

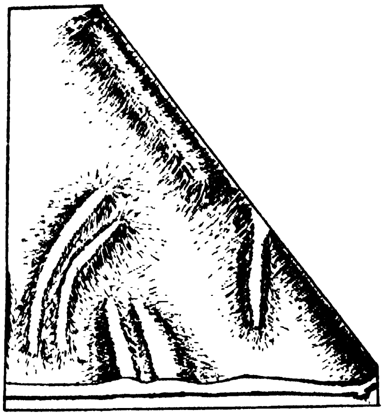


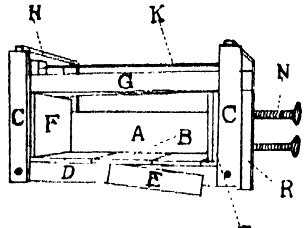
FIG. 2

R. H. MITCHELL

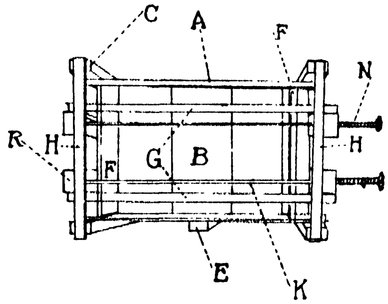
A MACHINE FOR THE INVESTIGATION OF STRUCTURE

IN laboratory experiments carried on for the purpose of investigating mountain structure it has seemed desirable to devise an apparatus that will overcome the difficulties of the narrow machines usually used. Such an apparatus is here described. The machine is simply a box, the ends of which may be freely approached towards each other, making it possible to compress layers of material placed between them in the box. This machine has worked very satisfactorily and has been found quite capable of withstanding a great pressure.

The inside dimensions of the box are: length, about 31 in.; width, 22¾ in. The floor (B) and the side boards (A) are of one inch pine material nailed securely to a base of oak two by fours (D). The corner posts (C) are also oak two by fours and are two feet high. At each end of the box these uprights are fastened together by one inch pine strips (H). The movable end boards (F) are of oak. (Two end boards are used at the end upon which the pressure is applied, the outside one being protected by iron strips from the ends of the screws (N). Short oak two by fours (E) are bolted to the base and are turned to a vertical position to support the side boards when pressure is applied. The pressure is produced by means of four vice screws (N) set in four 4 x 4 oak posts (R), two of which are at each end of the box. These are fastened together by four iron rods (K) 11/16 in. in diameter running lengthwise across the box, two fastening the tops and two the bottoms of the posts. The end boards are kept from creeping upward by pine two by fours (G) which serve as a track.



Side view



Top view

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SPECIAL ARTICLES

THE RELATION OF TOTAL NITROGEN TO REGENERATION IN THE WILLOW

A CORRELATION between the carbohydrate-nitrogen relationship and growth has been shown by Kraus and Kraybill[1] and Murneek[2] for the tomato plant, Harvey[3] for the apple and Reid[4] for wheat and

[1] R. T. Chamberlin and F. P. Shepard, *Journal of Geology*, vol. 31, 1923.

[1] *Ore. Agr. Exp. Sta. Bull.* 149, 1918.
[2] *Plant Physiol.*, 1: 3–55, 1926.
[3] *Ore. Agr. Exp. Sta. Bull.* 200, 1923.
[4] *Amer. J. Bot.*, 26: 770–779, 1929; 27: 272–289, 1930.

squash seedlings. They find that increased nitrogen results in increased shoot development and increased carbohydrates stimulate root development. Hicks[5] has applied this relationship to explain polarity in regeneration in the willow (*Salix viminalis*). She states that prior to development, nitrogen is translocated to the apex and carbon flows to the base. Shoots develop in the area (apex) of lowest C/N ratio, and roots appear in the area (base) of highest C/N ratio. The writer, working with *Salix nigra*, found that Hicks's results hold for cuttings having a normal gradient of total nitrogen (from morphological apex to the morphological base), in a normal position, and with a well-developed shoot and root polarity. Under such conditions, shoots develop in the area (apex) of highest total nitrogen per gram dry weight of cutting, and roots appear in the area (base) of lowest total nitrogen per gram dry weight of the cutting. Inverted cuttings, however, show different results. *A*, Fig. 1, shows an inverted cutting

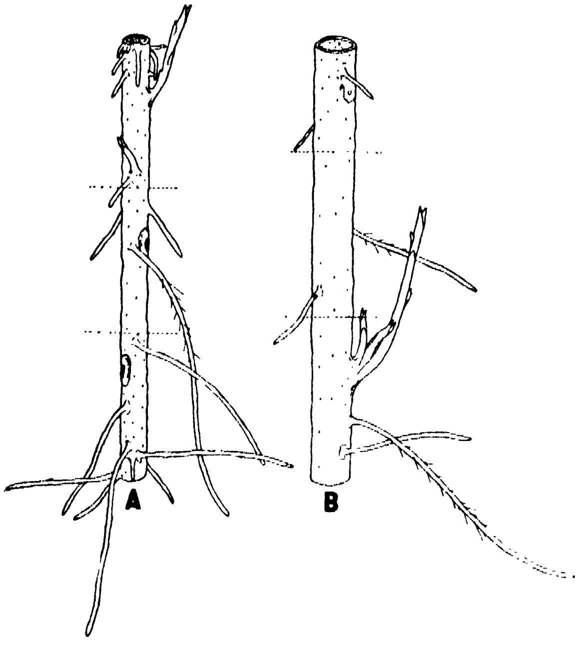

FIG. 1. *A*, an inverted cutting in which the gradient of total nitrogen is from the morphological base to the apex. *B*, an inverted cutting in which the gradient of total nitrogen is from the morphological apex to the base. The parts above and below the dotted lines were used for total nitrogen analyses.

in which the gradient of total nitrogen was from the morphological base to the apex, rather than from the morphological apex to the base, as is found in normal cuttings. The total nitrogen analyses (Table I) show that shoots develop in the area (morphological base)

TABLE I

TOTAL NITROGEN ANALYSES OF CUTTING A

The total nitrogen of the bark and wood is shown in milligrams of nitrogen per gram dry weight of the material. The total nitrogen of the roots and shoots was adjusted to the dry weight of the bark.

Part used for nitrogen determination	mgs N per gm dry weight			
	bark	shoots	roots	wood
Morphological apex	17.3259		0.1359	2.3316
Morphological base	16.9161	1.0304	0.0453	2.0299

of highest total nitrogen per gram dry weight of the cutting, while roots regenerate along the entire cutting and are not confined to the area (morphological apex) of lowest total nitrogen per gram dry weight of cutting. *B*, Fig. 1, shows an inverted cutting with a normal gradient of total nitrogen from the morphological apex to the base. Total nitrogen analyses (Table II) show that shoots develop in the area (mor-

TABLE II

TOTAL NITROGEN ANALYSES OF CUTTING B

The total nitrogen of the bark and wood is shown in milligrams of nitrogen per gram dry weight of the material. The total nitrogen of the roots and shoots was adjusted to the dry weight of the bark.

Part used for nitrogen determination	mgs N per gm dry weight			
	bark	shoots	roots	wood
Morphological apex	15.3337	1.1389	0.0765	2.3609
Morphological base	15.4889		0.0201	2.6144

phological apex) of highest total nitrogen per gram dry weight of the cutting and roots appear (as in cutting *A*) along the entire cutting.

The data indicate that regardless of the position of the nitrogen gradient and the position of the cutting, shoots develop in the area of highest total nitrogen per gram dry weight, while roots are not confined solely to the area of lowest total nitrogen per gram dry weight, but may appear along the entire cutting.

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EFFECT OF FREEZING AND THAWING ON THE EXTRACTABILITY OF THE ALLEGED CHICKEN SARCOMA AGENT[1]

THE assumed cell-free transmission of chicken sarcomas has given rise to many speculations as to the possible nature of the transmitting agent. We purposely avoid discussing relative merits of various

[5] *Bot. Gaz.*, 86: 193–209, 1928.

[1] Based on a paper read before the National Medical Congress of Japan, Osaka, April 4, 1930.

notions that have been suggested, but refer only to the one recently advocated by certain authorities, namely, that the so-called chicken sarcoma agent may be an enzyme-like substance.

The well-known fact that the "agent" is completely destroyed by an exposure to the temperature of 55° C. for 15 minutes (Rous) seems to have been entirely forgotten by the advocators of the "enzyme theory." In addition we previously showed that a potent desiccate of the sarcoma tissue can be inactivated mechanically by grinding it up in a mortar into extremely fine powder, indicating that the transmitting agent may be a formed body, not a chemical substance. In this paper we report another evidence, which may well be final. It is based on the freezing and thawing method of extracting endocellular enzymes.

Mashed Rous sarcoma tissue was divided into two portions, one of which was subjected to the process of repeated freezing and thawing. The freezing was done in a test-tube by means of the freezing mixture of ice and salt (temperature of − 18° C. for 20 minutes) or with the aid of dry ice (− 75° C. for 10 minutes), and thawing was accomplished by dipping the test-tube in water bath at the temperature of 37° C. for from 5 to 10 minutes. After repeating this process of freezing and thawing seven to ten times, the sarcoma material was extracted with 20 times its volume of physiological saline solution for 10 minutes with constant shaking, and then centrifuged. Simultaneously the control portion, which had remained in the ice-box, was similarly extracted and centrifuged under identical conditions.

The supernatant fluid (extract) of the two materials were then separately inoculated into normal chickens, the treated extract into the left, and the same amount of the control extract into the right pectoral muscle. It was noted that extracts from the treated material contained a far smaller number of sarcoma cells than the control extracts. Sediments of the treated and control materials were also similarly tested as to their comparative tumor-producing actions.

The result of such inoculations into 30 chickens demonstrated conclusively that the process of repeated freezing and thawing very strikingly reduces the tumor-transmitting action of the sarcoma materials, both extract and sediment. With untreated materials, large tumors, often replacing the entire "breast," were produced in 7 to 10 days, while tumors resulting from treated materials were always decidedly smaller. Moreover, treated materials failed to produce tumors in 5 out of 30 cases, but untreated materials gave rise to a tumor in every case.

The point which we consider most significant in these results is the very feeble tumor-producing action of the extract from the sarcoma tissue subjected to repeated freezing and thawing. This process disrupts many sarcoma cells and should facilitate the liberation of any enzyme-like substance contained in the cells. Therefore, if an enzyme-like tumor-producing agent were contained in the sarcoma cells, extracts obtained from disrupted cells should be much more potent than extracts obtained from untreated, intact cells. Our results radically contradict this expectation and show that the extracts obtained from disrupted sarcoma cells are much less active than those prepared from intact cells. On the basis of this fact we conclude that the Rous chicken sarcoma does not contain any enzyme-like agent capable of sarcoma transmission.

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BOOKS RECEIVED

BRAMBELL, F. W. ROGERS. *The Development of Sex in Vertebrates.* Pp. xvi + 261. 24 plates. Macmillan. $4.00.

CRAWFORD, RUSSELL T. *Determination of Orbits of Comets and Asteroids.* Pp. xi + 233. McGraw-Hill. $4.00.

CREW, HENRY, and KEITH K. SMITH. *Mechanics for Students of Physics and Engineering.* Pp. xvi + 371. 215 figures. Macmillan. $4.00.

CROSS, CHARLES N. *Heat Engines.* Pp. x + 607. Macmillan. $6.00.

ELTON, CHARLES. *Animal Ecology and Evolution.* Pp. 96. Oxford University Press. $1.50.

FITZPATRICK, HARRY M. *The Lower Fungi: Phycomycetes.* Pp. xi + 331. McGraw-Hill. $4.00.

GOODRICH, EDWIN S. *Studies on the Structure and Development of Vertebrates.* Pp. xxx + 837. 754 figures. Macmillan. $10.00.

GREGORY, THOMAS C., Editor. *The Condensed Chemical Dictionary.* Second edition, revised. Pp. 551. Thumb indexed. Chemical Catalog Company. $10.00.

HALDANE, J. S. *The Theory of Heat-Engines, Including the Action of Muscles.* Pp. xv + 120. Oliver & Boyd, London. 6/-.

HEGNER, ROBERT, and JUSTIN ANDREWS, Editors. *Problems and Methods of Research in Protozoology.* Pp. ix + 532. 32 figures. Macmillan. $5.00.

HENDERSON, ARCHIBALD. *Contemporary Immortals.* Pp. xiii + 209. Illustrated. Appleton. $2.50.

HOLMYARD, ERIC J. *An Introduction to Organic Chemistry.* Pp. xi + 280. Illustrated. Longmans, Green. $1.75.

MAXIMOW, ALEXANDER A. Completed and edited by WILLIAM BLOOM. *A Text-Book of Histology.* Pp. xiii + 833. 604 illustrations. Saunders. $9.00.

SHETRONE, HENRY C. *The Mound-Builders.* Pp. xx + 508. 299 figures. Appleton. $7.50.

Tables Annuelles Constantes et Données Numériques de Chimie, de Physique, de Biologie et de Technologie. Volume VII, Années 1925–1926. Pp. xv + 947—1896. McGraw-Hill. $25.00.

THOMSON, G. P. *The Wave Mechanics of Free Electrons.* The George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University. Pp. 178. 58 figures. McGraw-Hill. $2.50.

SCIENCE

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THE TAXONOMIC OUTLOOK IN ZOOLOGY[1]

By W. T. CALMAN, D.Sc., F.R.S.

THE selection of a systematic zoologist for the honor of addressing you from this chair implies a belief that systematic zoology may have something to say that will not be without interest to those whose studies lie in other fields. I am not sure how far this belief is generally shared. The anatomist, the physiologist, the field naturalist, the student of one or other of the innumerable specializations of biological science, has always been inclined to regard with distaste, if not with contempt, the work of those whose business it is to denominate, classify and catalogue the infinite variety of living things. The systematist is generally supposed to be a narrow specialist, concerned with the trivial and superficial distinctions between the members of some narrow group of organisms which he studies in the spirit of a stamp collector; happy when he can describe a new species, triumphant if he can find an excuse for giving a fresh name to an old one.

[1] Address of the president of Section D—Zoology, British Association for the Advancement of Science, Bristol, September, 1930.

It would be idle to deny the truth that there is in these criticisms, just as it would be easy, although unprofitable, to point out that the substance of them might be directed against the practice of most other branches of research. The specialist, of whatever kind, has a tendency to mistake the means for the end, to become fascinated by technique and to suffer from a myopia that blurs his vision of other fields than his own.

I think, however, that there are some signs of an increasing appreciation of the usefulness and even of the scientific value of taxonomy among the younger generation of zoologists. More particularly, those who are concerned with the applications of zoology to practical affairs are, for the most part, although not invariably, aware of the need for exact identification of the animals they deal with. They do not always realize the difficulties that may stand in the way of this identification. It is a common experience with us at the Natural History Museum to have some mangled fragments of an animal brought in by a

practical man who expects to be supplied with the name of it while he waits. I am afraid that he often goes away with a low opinion of our competence.

It may not be without interest, therefore, if I attempt, in the first place, to give some idea of how matters stand with this part of the systematists' task, the identification and description of the species of living animals.

When Linnaeus published in 1758 the first volume of the tenth edition of his "Systema Naturæ" he named and described about 4,370 species of animals. If we ask how many are known to-day the diversity of answers we get is some indication of the confusion that exists. Some years ago, at the request of the late Sir Arthur Shipley, I endeavored to get from my colleagues at the museum estimates of the numbers of species in the various groups with which they were specially conversant. Some of the answers obtained were very interesting. With regard to mammals I was told "anything from 3,000 to 20,000 according to the view you take as to what constitutes a species." For the most part, however, the authorities consulted were unwilling to suggest even an approximate figure for a very different reason. They told me that great sections of the groups with which they were concerned were so imperfectly surveyed that it was quite impossible even to guess how many of the supposed species that had been described would survive reconsideration.

It may be worth while to consider for a little the second of the two obstacles thus indicated as standing in the way of obtaining a census of the known species of animals. In the days of Linnaeus it is likely that a very experienced zoologist might have been able to recognize at sight any one of the four thousand species of animals that were then known, and when the expansion of knowledge had made such a feat no longer possible, the specialist who confined his studies to one section of the animal kingdom could still aspire to a like familiarity with the species of his chosen group. With this kind of knowledge it is literally true that, as has been said, a systematist recognizes a new species by instinct and then proceeds to search for the characters that distinguish it. Some of the great zoologists who were still working in the British Museum when I entered it more than a quarter of a century ago, men like Albert Günther, Bowdler Sharpe, C. O. Waterhouse and Edgar Smith, had actually an amazing personal familiarity with vast sections of the animal kingdom. They had studied and digested all that had been written on their subject, and if they did not carry the whole of this knowledge in their memory, they could without searching put their hand at once on the volume that would help them. They had no need of "Keys" to help them to run down their species, indeed they rather distrusted such aids for they knew how easily they betray the heedless. Specialists of this type there must always be and we may be thankful for it. Nothing can altogether replace that instinctive perception of affinity that comes from lifelong study. It has often happened that men such as those I have named were able, when confronted with new and aberrant types of animals, to allot them at once to a place in classification which subsequent research served only to confirm. As time goes on, however, the extent of ground that can be covered in this fashion by the most industrious worker is rapidly diminishing. The torrent of publications catalogued in the *Zoological Record* increases year by year, and the specialist, if he is not to be overwhelmed by it, must not allow his curiosity to stray beyond the limits of a narrow corner of the field.

By far the greater part of this literature is written by specialists for specialists, and much of it is unintelligible to any one else. From the time of Linnaeus, however, there have not been wanting publications that have a different aim. We have monographs, synopses, revisions, of all sorts and sizes, attempting to render possible the identification of species without demanding a lifetime of study for each special group. The ideal for such monographs would be, I assume, that they should be intelligible to, and render possible the determination of species by, any properly trained zoologist, even without previous experience in dealing with the particular groups of which they treat.

The zoological department of the British Museum may fairly claim to have done more towards this reediting of the "Systema Naturæ" than any other institution in the world. The long series of monographs, of which the true character is somewhat concealed under the official title of "catalogues," is a monument to the learning and industry of the great zoologists who planned and executed them. Though they remain indispensable to all serious students of the different groups, however, they are now for the most part long out of date, and vast as is their scope, they cover only a fraction of the animal kingdom.

In 1896 the German Zoological Society began the publication of "Das Tierreich," afterwards continued by the Prussian Academy, which was planned to give nothing less than a revision of all the species of living animals. Here again, however, after thirty-four years, only a small part of the ground has been covered and already the progress of research has rendered many of the earlier parts obsolete. Colonel Stephenson tells me that Michaelsen's revision of the Oligochaeta, published in this series in 1900, deals with exactly half the number of species enumerated by the same authority in 1928.

Apart from these attempts at comprehensive revision we have, of course, numerous surveys of local

faunas on a larger or smaller scale, besides monographs of restricted groups, but hardly ever do these fit together without leaving gaps, geographical or systematic.

Take, as an example, the brachyurous Crustacea or true crabs. No revision of the Brachyura as a whole has been attempted since Henri Milne-Edwards' "Histoire Naturelle des Crustacés" published nearly a century ago. The student who wishes to identify a collection of crabs has to begin with local faunas, such as Alcock's invaluable "Materials for a Carcinological Fauna of India" and Miss Rathbun's monographs of the American species; but for regions that have not been thus studied there is no way but to search out and compare the descriptions of species in innumerable obscure publications by writers who had often an imperfect knowledge of what had been done elsewhere. The genus *Pilumnus* is one that is abundantly represented in all the warmer seas of the globe. No revision of its numerous species has been attempted in recent times. I do not even know how the genus is to be defined from neighboring genera; and yet hardly any report on a collection of tropical crabs does not profess to describe at least one new species of the genus.

Another example from a very different group of animals is given by the aberrant lamellibranch Mollusca forming the family Teredinidae, commonly known as "shipworms." During the past ten years a great deal of attention has been given to these animals in the effort to discover means of combating or avoiding their attacks on the timber of harbor works and the like. Nevertheless, the taxonomy of the group remains in a state of the utmost confusion. There is no agreement as to the limits even of the genera, and the inconstancy of the characters that have been used for the definition of species is plain to any one who studies a large collection. Only in one species, the long-known and often-studied *Teredo navalis* of Linnaeus, have we any detailed information as to variability and the changes that take place during growth. In these circumstances the publication of new specific names, except after prolonged study of ample material, can not be regarded as a serious contribution to knowledge. Dr. Bartsch, of Washington, in his "Monograph of the American Shipworms" (1922) simplified his task by the assumption that any species found on the coasts of the American continent must, of necessity, be different from any found elsewhere, and he was thus able to write "n.sp." after twenty-two out of the twenty-nine specific names. It was soon shown, however, by other American zoologists, that this assumption was without foundation, and that the most destructive species on both the Atlantic and Pacific coasts of North America was the European *Teredo navalis*.

A thorough revision of the taxonomy of the shipworms would be a task of much difficulty but it would be of great scientific interest and it might even be of great practical importance. Those who are carrying out experiments on the protection of timber, in this country at least, seldom trouble to inquire what species they are dealing with or even whether they are always dealing with the same one. Professor Barger, for instance, who speaks of *Teredo* as a "species" does not seem to think that it matters. Perhaps it does not, but it is just possible that it does. We do know that different species differ greatly in susceptibility to changes in the salinity of the water, and it seems worth while to ask whether they all react in exactly the same way to the poisons that the chemists try to administer to them. The fact that our knowledge of their specific differences is still very incomplete is no reason why the chemists should not avail themselves of such knowledge as we have.

One cause that has encumbered systematic literature with uncounted pages of useless writing is the prevalent delusion that it is possible to give what is called a "complete description" of a species. This phrase is apparently intended to denote an enumeration of the visible features of the organism so exhaustive as to include not only the characters differentiating it from the other species already known but also those that will serve to distinguish it from species yet to be discovered. Now a moment's reflection will show that a lifetime would not suffice for the complete description of any animal whatsoever, and on the other hand, a very little experience will convince one that it is impossible to predict the kind of characters that will distinguish the next new species. Some years ago I found that all the specimens of the genus *Squilla* in the museum collection from West Africa differed in half a dozen constant, and, once they were pointed out, conspicuous characters from their nearest congeners. It happened that shortly before a German zoologist had given what was intended to be a complete description of a *Squilla* from the same region. His account extended to two large quarto pages, and yet it succeeded in avoiding mention of every one of the features that proved to be distinctive of the species.

If every one who describes a new species were to restrict himself to a bare enumeration of the characters in which it differs from all the known species of its genus, systematic papers might be vastly diminished in bulk, although one suspects that the labor necessary to write them might be correspondingly increased. It may be a counsel of perfection to suggest that no one should introduce a new specific name without undertaking at least a partial revision of the genus including it, but there are very many instances where the multiplication of species might with advan-

tage be postponed until we learn something about those that are supposed to be known.

The number of described species of animals has been estimated at something in the neighborhood of three quarters of a million. It is not at all improbable that between a quarter and a third of that number would be suppressed as synonyms or put aside as *species inquirendae* by careful monographers and that in many groups the proportion would be far higher.

The prospect is not one that can be contemplated with any satisfaction. The successively expanding volumes of the *Zoological Record* give us a picture of systematic zoology being smothered under the products of its own activity. The confusion will grow steadily worse unless systematists come to realize that the mere description of new species is a far less important thing than the putting in order of those that are supposed to be already known, and until, on the other hand, zoologists in general cease to regard taxonomy as a kind of menial drudgery to be done for them by museum curators.

I have alluded to another obstacle to obtaining an enumeration of the animal kingdom in the divergences of opinion as to what constitutes a species. I am not sure that these divergences are not sometimes overestimated. I think that it will be found that in most orders of animals there exists a considerable body of species regarding whose limits there is no serious difference of opinion among competent systematists; but alongside of these we find in almost every order, in most families and even in many genera a difficult residue in which the delimitation of specific groups sometimes seems to be little more than a matter of personal taste. My colleague Mr. Robson has recently brought together a great deal of information on this subject in his book "The Species Problem" to which I would refer any one who needs to be convinced how complex the problem really is. For our present purpose it is enough to take the empirical fact that the majority of animals can, with more or less trouble, be sorted into assemblages or kinds that we call species. We have seen how imperfect and confused is the present state of knowledge even as regards the mere description and identification of these kinds.

The business of the systematist, however, does not end with identification. Even identification requires some kind of classification, if it is only the classification of the dictionary. Since the time of Linnaeus, or rather since the time of John Ray, zoological systematists have believed in the existence of a natural system of classification which it was their business to discover; since Darwin it has seemed plain that this natural system must be, in some way, based upon phylogeny. It has now realized that the relation between the two is not always so simple and straightforward as it once appeared to be. Dr. Bather, in his presidential address to the Geological Society in 1927, discussed the historical and philosophical bases of biological classification. He concluded that "the whole of our system, from the great phyla to the very unit cells, is riddled through and through with polyphyly and convergence" and that "important though phylogeny is as a subject of study, it is not necessarily the most suitable basis of classification." I am not sure that I quite understand what is implied by the second of these statements, but I do not suppose that even Dr. Bather would be prepared to suggest a system of classification entirely divorced from phylogenetic considerations.

Forty years ago the reconstruction of the evolutionary history of the major divisions of the animal kingdom was almost universally regarded as the chief end of zoological research. To-day, except among paleontologists, one might almost say that the phylogenetic period in the history of zoology has come to an end. When one recalls the extravagances of its later developments, the derivation of vertebrates from arachnids and of echinoderms from cirripedes, one can not be surprised that zoologists of the modern school take little interest in it. If we accept this attitude, it follows that problems of affinity and relationship are not worth worrying about. We are told, in so many words, that our business as systematists is identification, not classification; that what we have to do is merely to devise some kind of key or card-index that will enable animals to be quickly and easily sorted into species. As far as the really scientific branches of zoology are concerned an artificial system of classification is as good as, and may even be better than, any other. An illustration of this attitude of mind is seen in a paper recently issued from Cambridge in which *Lithodes* is replaced, without explanation or discussion, among the Brachyura—which, on the card-index system, is doubtless its appropriate place.

It is quite true that the categories of the physiologist, the ecologist, the geneticist, and so on, often cut across the dividing lines of the most natural classification we can devise, but both the divergences and the coincidences are worthy of closer consideration than they sometimes receive. If there is any truth in the theory of evolution it is obvious that functions and habits have an evolutionary history behind them, but it is no less obvious that this history has not been independent of the history of the organisms that display them. The details of this history we shall never fully know and even its broad outlines may perhaps always remain misty. A natural system of classification expressing even these broad outlines may prove to be an unattainable ideal, but each step towards it

holds out the promise of usefulness in other and possibly remote fields of research.

A great deal of current work and still more of current speculation in zoology seems to me to suffer from this neglect of the taxonomic outlook. In the zoology of the later nineteenth century the comparative method was still the chief tool of morphology. The relative importance of structural characters was measured by the extent of their persistence through larger or smaller divisions of the animal kingdom. This point of view tends to be lost sight of with the increasing emphasis on the experimental method. The systematic zoologist, in listening to the exponents of the modern lines of research, is apt to be impressed by the little account that is taken of the vast variety of animal life. To say this is not to underrate in any way the advances that have been made in these lines within the present century or the revolutionary changes they have made in our views on many fundamental questions. Physiology, for example, is to-day a vastly different science from what it was thirty years ago, partly because the physiological laboratory has a more varied fauna than it had then. Nevertheless, the zoologist, conscious of the unending diversity of structure and of habits among animals, sees the physiologist's results against a background of which the physiologist himself seems to be sometimes forgetful.

One hesitates to suppose that the students of heredity are really so forgetful of this background as they sometimes seem to be. No doubt intense specialization is needed for intense research; but the poet of the breakfast table, laughing gently at the narrow specialism of the Scarabee, can hardly have foreseen the day when a university in his own country would have upon its teaching staff an officer named in the university calendar as a "Drosophilist."

It is possible, however, that the prevailing lack of interest in questions of phylogeny may have a deeper significance. Those departments of biology that are being most actively studied at the present day are preoccupied with the interplay of forces acting here and now. They ignore the impressions that time may have left on the material of their study. It is as though a crystallographer, studying a pseudomorph, should endeavor to explain its form in terms of its chemical composition and the forces governing the arrangement of its molecules, without taking account of its past history.

From ignoring anything, it is but a short step to denying its existence, and here, it seems, we have already arrived. Some of you may possibly have listened to a lecture delivered in London in the early part of last year by that very distinguished experimental biologist Dr. Hans Przibram, in which he suggested that we might have to consider the possibility that every species of metazoan had developed independently of all the others from a distinct species of protozoan. The same view was set forth by him in a lecture delivered in Paris on the "Theory of Apogenesis."[2] As the English lecture has not been published I will translate as closely as I can from the French one:

> I do not think it likely that a single substance can have given rise to a general phylogenetic tree according to the classical diagram representing the affinities of species and their distribution in space and time. All the facts would be explained more easily by supposing that there existed, at the beginning, many organized substances developing side by side into species, each of the latter passing through stages more and more advanced without actual relationship of descent between the different species.

Many authors have believed in a multiplicity of the primordial forms of life, but few have suggested an independent origin for grades lower than the main phyla. Przibram, with strict logic, has carried the same reasoning down to the individual species. Most biologists with whom I have discussed the matter refuse to take his suggestion seriously. This, I venture to think, is a mistake. Przibram has simply carried to their inevitable conclusion certain lines of thought that we meet with everywhere in current biological literature; that conclusion is either one of the most significant results of recent biology or it is the *reductio ad absurdum* of much contemporary work.

Geneticists have made us familiar with the doctrine of the inalterability of the gene, with its corollary of evolution by loss of factors, which, by the way, seems to differ little from Przibram's apogenesis. The experimentalists have proved (if it wanted proving) the plasticity of the phenotype, as, for instance, when Przibram himself shows that the length of a rat's tail is a function of the temperature to which the individual and its immediate progenitors have been exposed. As for the inheritance of impressed modifications, the more unequivocal the experiments devised to demonstrate its reality the more clearly do they show it to be of so fugitive a kind as to have no significance in evolution. Paleontologists, as Dr. Bather has told us, have proved beyond the possibility of doubt the occurrence of parallel and even of convergent evolution, without telling us where we are to stop in applying the principle. Many supposed examples of adaptation fail to stand closer scrutiny, and therefore the whole idea of adaptation is declared to be a subjective illusion. All these results at any rate place no obstacles in the way of Professor Przibram's suggestion.

[2] *Rev. Gen. Sci.*, 11 (No. 10): 293, May 31, 1929.

It is to be noted that although the theory of apogenesis is called a theory of evolution it does not deal at all with evolution as that word was used by Darwin. It has nothing to say on the origin of species. On this question it is no more than a doctrine of special creation at one remove. It has no light to throw on classification. If we are to abandon belief in community of descent the whole architecture of the "Systema Naturæ" becomes meaningless.

Professor Przibram claims that "all the facts would be explained more easily" upon his hypothesis, but there is one point on which he speaks with a hesitant voice, and it seems to me a very significant exception. "We can not decide," he says, "whether the differing though related species that inhabit islands or isolated territories are descended from a common source or result from the accidental separation of species which formerly occupied the region together."

Let me recall to you the opening words of the "Origin of Species": "When on board *H. M. S. Beagle* as naturalist, I was much struck with certain facts in the distribution of the organic beings inhabiting South America, and in the geological relations of the present to the past inhabitants of that continent." So Przibram ends where Darwin began. The geographical and geological distribution of organisms, which for the one are merely the negligible residue of unexplained facts, were for the other the very heart and core of the problem he set himself to consider.

It is worth remembering that among Darwin's other qualifications as an interpreter of nature he was an experienced taxonomist, and before he wrote the "Origin of Species" he had produced one of the finest systematic works ever written in his "Monograph of the Cirripedia." Those of us who were present at the memorable Darwin-Wallace celebration of the Linnean Society in 1908 remember how the veteran Alfred Russel Wallace discussed "the curious series of correspondences both in mind and in environment" which led Darwin and himself, alone among their contemporaries, "to reach identically the same theory," and how he gave the first place to the fact that both he and Darwin began by collecting beetles and thus acquired "that intense interest in the mere variety of living things" which led them to speculate upon the why and the how of "this overwhelming and, at first sight, purposeless wealth of specific forms among the very humblest forms of life." It might be worth while to inquire whether a training that proved useful to Darwin and to Wallace would not be of some value to students of zoology even at the present day.

My predecessor in this chair told you that "the present position of zoology is unsatisfactory," and he found the chief hope for the future in the application of the experimental method. He may be right. I am not so sure. The experimental method has answered many questions and it will answer many more, but there are some questions, and these well worth the asking, to which experiment will never find an answer. No one will maintain that taxonomy by itself will answer them, but it will often suggest where the answer is to be sought for, and it will provide a standpoint from which both questions and answers will be seen in a true perspective.

Finally, I would recall a remark once made in my hearing by a wise old naturalist, the late Dr. David Sharp. Some one had been remarking on the decline of systematic zoology and predicting the extinction of systematic zoologists. Dr. Sharp replied, in effect:

> I have seen many passing fashions in zoology, many departments of research becoming popular and then falling into neglect; the one branch that will never fail to attract is the systematic one. The esthetic satisfaction to be derived from contemplating the mere variety of animal forms and from tracing the order that runs through all its diversity appeals to a very deep instinct in human nature. There will always be systematic zoologists.

THE USEFULNESS OF PSYCHOLOGY[1]

By J. McKEEN CATTELL

IT is a pleasure to receive this beautiful gold medal of the Society of Arts and Sciences from Mr. Russell, the president of the society, who in its conduct and in other directons has endeavored to bring together the fine arts and the natural sciences. In some of its aspects science is a fine art and both are children of the creative imagination, born with hard labor. As Keats wrote:

> Beauty is truth, truth beauty;—that is all
> Ye know on earth, and all ye need to know.

It is a satisfaction to be introduced by Professor Thorndike, my friend and colleague for more years than he might like me to tell. To him we owe in large measure the present application of psychology to education, the most useful achievement of our science.

It is an honor without parallel to be associated with the earlier recipients of this medal in science, Mr. Edison, Professor Michelson and Dr. Millikan,

[1] Address at a dinner of the Society of Arts and Sciences, the Hotel Biltmore, New York, on the occasion of the award of the medals of the society, April 17, 1930.

three of those to whom America and the world owe the most, and now with Professor Lewis, preeminent in what is perhaps the most fundamental of the sciences.

At the dinner of this society a year ago when its medals were presented to Professor Michelson and Dr. Millikan, Professor Michelson said that he had done his work "for the fun of it" without regard to its usefulness, though he seemed pleased that his superexact measurements of the velocity of light might be applied to topographical surveying. Dr. Millikan, however, chose as his subject "The Economic Value of Michelson." It is on the economic value of psychology, its usefulness to our modern civilization, that I shall speak for the twenty minutes allotted to me. Before an audience of distinction—I assume that the IQ's range from 150 to 200—I wish to urge the need of united efforts to advance psychology and its applications in the interest of all the professions and of our national life.

When an International Congress of Psychology met for the first time in the United States last year, it marked the fiftieth anniversary of our science, for the first laboratory was established by Wilhelm Wundt, professor of philosophy at Leipzig, in 1879. The first professorship of psychology, held by me, was established at the University of Pennsylvania in 1888. When the American Psychological Association was organized in 1892 there were 31 members, not more than half of whom would now be regarded as psychologists. At the recent congress there were in attendance 826 American psychologists each of whom was supposed to have advanced psychology by research. Our science is young; it is growing fast, as youth should. But we have as yet no institutes for psychological research or schools of applied psychology.

The engineers of the country celebrated last week fifty years of progress in mechanical engineering. It is a remarkable record and one to which America has contributed more than its share. The first schools of engineering were established only one hundred years ago; the industrial revolution may be dated from the use of the steam engine of Watts in the coal mines of Cornwall one hundred and fifty years ago; the physical sciences, on which engineering is based, are scarcely older than Galileo, say three hundred years. Physics is six times as old as a science of psychology; it required two hundred years to construct a scientific foundation on which a profession of engineering could be erected.

There was celebrated last week the eightieth birthday of Dr. William H. Welch, of the Johns Hopkins University, who in his lifetime has witnessed and largely contributed to the establishment of a science of medicine. We can scarcely place its foundation earlier than Pasteur, though medical schools go back to the University of Salerno, a thousand years ago. Medicine had to await the development of the biological sciences before an empiric art could become an applied science. As biology is less advanced than physics, so medicine, despite its long history, is on a less secure scientific basis than engineering.

Medicine, law and theology, together with philosophy, were the faculties of the university until engineering emerged a hundred years ago. Teaching is one of the earliest of the arts, but schools of education are only about as old as the present century. Law, the work of the churches, and education are on a less satisfactory foundation than medicine and engineering because there has not been an adequate science of human behavior on which they could be based. It is no less necessary that these professions should stand on a science of psychology than that medicine should stand on biological science, engineering on physical science.

Law and theology, dependent on tradition, precedent, words and an obsolete psychology of property rights and souls, of rewards and punishments, of motives, virtue and sin, are at present in the position of medicine before it had a foundation of science. The story is told of an argument between a judge and a bishop as to whether the courts or the church had the greater power. The judge finally said that the court could condemn a man to death, to which the bishop replied that the church held the keys of heaven and of hell. "That may be," said the judge, "but when I say that a man shall be hanged, he is hanged." But we do not know whether heaven should be promised, and if so to whom, whether men should be hanged, and if so which.

Teaching has done more to adapt itself to modern conditions and to make use of what scientific psychology we have. But human conduct has been altered and controlled by invention and engineering to a far greater extent than by the churches, the schools or the courts of law.

Business and industry are now becoming professions with their own schools, from the commercial high school to the graduate school of Harvard University. These professions, like law, the churches and the schools, are principally concerned with the behavior of individuals and for their development require a science of psychology. The boys who go from college into business far outnumber those who enter any of the older professions or perhaps all of them together. Yet they must develop their own social organizations and athletic competitions as a

preparation, because we have no adequate psychology of conduct that can be used as a basis, in the way that the biological and physical sciences are used for medicine and engineering. Men of business and affairs are psychologists, but in the sense that farmers are biologists, not as physicians are biologists or engineers are physicists.

It may also be that the study and practice of medicine and engineering will be greatly advanced when we realize the extent to which they should be based on understanding and controlling behavior. A painting in the library of the Engineering Society's building in this city bears the inscription: "Engineering—the art of organizing and directing men and of controlling the forces and materials of nature for the benefit of the human race." According to this definition, chosen by engineers, the relations between engineering and psychology are close. The selection, training and directing of men are problems of applied psychology; it is also for psychology to determine what does in fact benefit the human race. In using the forces and materials of material nature engineering has become an exact science; in its relation with human nature engineering works by the rule of thumb and will continue to do so until it can use an exact science of psychology.

The objects of applied psychology, namely, the control of the behavior of individuals, have been advanced by invention and industry to an extent incomparably greater than has been accomplished by psychology, or by the sciences and professions directly concerned with human nature. The applications of science, by quadrupling the wealth that each can produce and by doubling the average length of life, have completely altered our civilization and the way that each of us reacts to it. The economy of labor and of life which science and invention have caused has abolished slavery and serfdom. It has made productive labor by children needless and has made possible their universal education. The wealth of society is now sufficient to support adequately every child, to give it the education that opens the gateway to the career for which it is fit, to provide equality of opportunity and a true social democracy. Applied science, based in large measure on scientific research whose utility was not at the time obvious, has been the cause of the political and social institutions that we have and of the lives that we lead.

The applications of science have done more to control our behavior than efforts made with this object directly in view, such as those of the churches, the schools, the courts and the state. It may be argued plausibly that the ten commandments would have been broken no oftener, that the precepts of the Sermon on the Mount would have been followed no less rarely, if the churches had never existed. It may be that it is as futile to herd children in pens to teach them their R's as it would be to use similar methods to teach them to walk and to talk. It is quite possible that there would be no more crime in the world if courts and prisons had never been invented.

These partial failures to alter human nature by direct appeals to consciousness are quoted to emphasize the thesis that applied psychology is concerned with the total relation of the individual to the environment. We can try to alter the individual; but we can accomplish more by altering the physical world in which he lives, perhaps most of all by altering the relation of an individual to his surroundings. As modern medicine has made more progress in the diagnosis of disease than in its cure, so psychology can determine the intelligence of a child or a congressman more readily than it can increase it. In like manner as medicine and public hygiene can do more for the health of people by providing surroundings that are sanitary than by curing diseases that have been contracted, so psychology can do more by placing individuals in surroundings where they will act in the way that is wanted than by attempting to change individuals, so that under the same conditions they will act in a more desirable way.

The placing of individuals in the situations in which they act in the way most desirable for them and most useful for society is surely an undertaking the value of which can scarcely be overstated. If every one, from the feeble-minded child to the man of genius, were permitted to do the work that he can do best and were trained to do it in the best way, happiness would be increased on a scale for which we have as yet no units of measurement, the annual production of wealth would perhaps be doubled.

But even this story is not the most extravagant that can be told. The selection of existing individuals for the work for which they are best fit is a small matter in comparison with selecting the individuals themselves. Eugenics is at present only an amateur science—Professor Conklin has called it an "infant industry"—but in the distance it looms up in proportions as immense as they are vague. Darwin tells us that when *The Beagle* was visited by South American savages, they showed no curiosity or concern about the ship, but were greatly interested in a rowboat which came within range of their experience. So it is with eugenics—to us as *The Beagle* to the savages—which must be passed with the guess that here the psychological and biological sciences will ultimately find their greatest work.

The control of thoughts, emotions and behavior

has been undertaken by the churches, the schools, the laws and the rest in order to accomplish definite results that are regarded as desirable, but they have largely failed because it is difficult to change human nature. What we can do is determined when we are born; what we actually do depends on circumstance. Individuals at birth have definite constitutions and will react to their surroundings in accordance with them. But we can place them in situations where they will behave as nearly as their constitutions permit in the way that we want. By changing the surroundings we control behavior most effectively. This is what our industrial civilization has done, but it has advanced without special reference to the kind of mental life and behavior that will follow. What we need is a science that will coordinate all efforts to control conduct with the effects of all changes in the environment. This is the primary business of psychology; it requires the cooperation of all the sciences and of all the professions.

As I understand it this medal of the Society of Arts and Sciences has been conferred on a science rather than on an individual. It is a recognition of what psychology has accomplished within a period of fifty years, a mark of confidence in what psychology will do in the future.

OBITUARY

FLORIAN CAJORI

ON August 14, 1930, there died at Berkeley, California, Florian Cajori, the most prolific and best-known writer on the history of mathematics that this country has produced. He was not, however, a native of America, having been born at St. Aignan, near Thusis (Graubünden), Switzerland, on February 28, 1859, and having come to the United States at the age of sixteen. Entering the University of Wisconsin, he received the degree of B.S. in 1883, spending the year 1884-1885 in graduate work at the Johns Hopkins. He then went to Tulane University (1885) as assistant professor of mathematics, becoming professor of applied mathematics two years later (1887). In 1889 he went to Colorado College as professor of physics, subsequently taking the chair of mathematics (1898–1918) and becoming dean of the department of engineering (1903-1918). During all these years he paid particular attention to the history of the subjects of his major interest, and in recognition of his work in this field he was called to the University of California in 1918 as professor of the history of mathematics, a unique title either in this country or abroad. This position enabled him to devote his time largely to research and writing, and the result amply justified the action of the university in creating the position, and his own decision in accepting it.

Forty years elapsed from the date of the publication of his "Teaching and History of Mathematics in the United States" (1890) to the time when death compelled him to lay aside the work which he had hoped to complete—an edition of Newton's "Principia." During these years his contributions to the history of mathematics, physics, geodesy and astronomy were numerous and of increasing value. Besides writing a large number of articles and making a brief excursion into the text-book field, he wrote the following historical works: "History of Mathematics" (1894, with a revised edition in 1919), "History of Elementary Mathematics" (1896, with a revised edition in 1917), "History of Physics" (1899), "History of the Logarithmic Slide Rule" (1909), "William Oughtred" (1916), "History of the Concepts of Limits and Fluxions in Great Britain from Newton to Woodhouse" (1919), "The Early Mathematical Sciences in North and South America" (1928), "The Chequered Career of Ferdinand Rudolph Hassler, First Superintendent of the United States Coast Survey" (1929) and the work by which he will chiefly be remembered—"The History of Mathematical Notations" (2 volumes, 1928, 1929).

It is interesting to see how he developed in the two-score years of his literary activity. His work of 1890, published when he was thirty-one years of age, showed a considerable range of study of source material and a commendable plan of exposition, but it also showed a lack of thoroughness and of finish. His next three books (1894, 1896, 1899) gave less evidence of the study of sources and showed a somewhat excessive dependence upon other writers, notably Gow and Cantor in the case of mathematics. It was not until he was invited to contribute to the fourth volume of Cantor's monumental treatise, the "Vorlesungen über Geschichte der Mathematik" (Leipzig, 1908), that he showed himself in his true light, that is, as an investigator of the history of mathematics whose work was based upon source material. From this time until his death his books displayed this new spirit. His history of the slide rule, though written twenty years ago, still stands as one of our best authorities. This led him to his first important biographical work, the life and labors of William Oughtred, the leading popularizer of mathematics in England in the first half of the seventeenth century. His other venture in the same field, the work on Hassler, may have been prompted by the fact that this leader in establishing

our coast survey was his compatriot, but in any case he succeeded in gathering a considerable mass of material about a man who contributed notably to the scientific work of America. The same spirt of careful research showed itself in his study of the history of limits and fluxions in England and in the investigation of the early mathematical sciences in the New World. By far his best work, however, is his "History of Mathematical Notations," a worthy culmination of his career as a historian. While it is greatly to be regretted that he did not live to publish his edition of the "Principia," he had the satisfaction of seeing this treatise on notations appear in a worthy form and of knowing that the scientific world fully recognized its merits.

His work was not by any means limited to his published books, however. He was a prolific contributor to a large number of scientific journals such as the *Bulletin* of the American Mathematical Society, Science, the *American Mathematical Monthly*, the *American Journal of Mathematics*, *Schlömilch's Zeitschrift*, *Silliman's Journal*, *The Scientific Monthly*, *Popular Astronomy*, the *Archivio di Storia del Scienza*, Loria's *Bollettino*, *Scientia*, *Bibliotheca Mathematica*, *Isis*, *Mathematical Gazette*, *Popular Science Monthly*, *School Science and Mathematics* and the *Publications* of the University of California and those of Colorado College. During his years at the University of California he contributed no less than 140 articles and reviews, all of high rank, to these and other periodicals.

His work was duly recognized by learned societies and by various colleges and universities. He was a member of the American Mathematical Society, the Mathematical Association of America, the Deutsche Mathematiker-Vereinigung, the Mathematical Association (England), the American Academy of Arts and Sciences and the American Association for the Advancement of Science, holding offices in at least two of these societies. He was honored by the degrees of Ph.D. (Tulane, 1894), LL.D. (University of California, 1912, and Colorado College, 1913) and Sc.D. (Wisconsin, 1913). As the leading historian of mathematics in this country, his loss will be deeply felt by all who have an interest in this important field of learning.

David Eugene Smith

RECENT DEATHS

Mr. Michael B. Rich, president of the board of directors of Williamsport-Dickinson Seminary, Pa., was killed in an automobile accident on August 8.

Father John George Hagen, S.J., director of the Vatican Observatory, died in Rome on September 6 at the age of 83. He was formerly director of the astronomical observatory at Georgetown University.

William Nelson Reid, for several years metallurgist in charge of the heat treating department of the International Motor Company at Plainfield, N. J., died on September 3.

The *Electrical World* reports the death in Milan of Professor Francesco Grassi, Italian electrical engineer, at the age of 78. Professor Grassi was one of the Italian delegates to the International Electrotechnical Congress in Chicago in 1893.

Nature reports the following deaths: Dr. Henry Fraser, formerly director of the Institute for Medical Research, Federated Malay States, when he made valuable contributions to our knowledge of beri-beri, bacillary dysentery and leprosy, on July 17, aged fifty-seven years; Mrs. Albert Howard, second imperial economic botanist to the Government of India, who was associated with her husband in the work of the Institute of Plant Industry, Indore, on August 18, aged fifty-three years; His Grace the Duke of Northumberland, K.G., president of the Royal Institution and chancellor of the University of Durham, on August 23, aged fifty years; Professor Conrad von Seelhorst, professor of agriculture in the University of Göttingen, author of "Handbuch der Moorkultur," on July 6, aged seventy-seven years.

MEMORIALS

On August 17 in the presence of the immediate family of the late Rear Admiral Robert Edwin Peary, U. S. N., and a large number of interested spectators, a boulder, bearing a bronze tablet describing the meridian line marked by Admiral Peary while a resident of Fryeburg, Maine, was unveiled with appropriate ceremony. The meridian has been used by surveyors since then, and is recognized by the United States topographical authorities for its accuracy. The principal speaker was Professor Alfred E. Burton, of Carmel, California, formerly dean of the Massachusetts Institute of Technology. Mrs. Peary unveiled the memorial, and Robert E. Peary, 2nd, spoke of his father.

SCIENTIFIC EVENTS

THE HARVARD SCHOOL OF GEOGRAPHY

Announcement was made on September 14 by officials of Harvard University of the establishment of a school of geography under the terms of a gift from a Harvard graduate, Dr. Alexander Hamilton Rice, of Newport, R. I., who is an amateur of the geographical

sciences and will serve as the first director of the institution, according to a report in the New York *Herald Tribune*.

The school is the second of its kind in the United States, and its building, which is in process of construction in Divinity Avenue, Cambridge, near the Semitic and University Museums and the University Press, is to be in Georgian style to harmonize with other Harvard structures. The roof will contain a chart house and will be flat to facilitate instruction and practice in field work and surveying. A library with stack rooms for 80,000 volumes, instrument room, drafting room, map room, wireless department and quarters for mathematical and physical geography are included in the plans.

The main objective of the school will be the teaching of the fundamentals of geographical science, with particular emphasis on the position of geography as a science concerned with the study of life and mankind. It will also be occupied with the correlation of the sciences of the biological group, for instructional purposes, with topography and regional geography and the principles of geographical description.

Instruction will be offered in the new auxiliary method of exploration and survey—photography from the air—together with the most approved and up-to-date methods of survey and field astronomy employed in work of an exploratory nature in regional geography. It is planned that the school shall take an active part in geographical exploration on various lines similar to that carried on at the English universities of Cambridge and Oxford.

Harvard officials point out that Cambridge is a particularly favorable location for the institution, since its quarters will be in the center of Harvard's scientific departments, from which every year numbers of expeditions go out to many parts of the earth in search of new material for study.

Dr. Rice has had extensive training and experience in the field of geographical exploration. In addition to his degrees from Harvard College and the Harvard Medical School he has received the diploma of the school of geographical surveying and field astronomy of the Royal Gèographical Society and an honorary A.M. degree from Harvard University. He has organized and conducted seven expeditions into tropical South America and has explored, mapped and described an area of more than 500,000 square miles of the Colombian Caqueta, the Brazilian Amazonas and the Venezuelan Guayana.

Dr. Rice is vice-president of the American Geographical Society from which he received the David Livingstone centenary medal in 1920. He is also an honorary corresponding fellow of the Royal Geographical Society, which awarded him in 1914 its Patron's gold medal, and he holds life memberships in numerous scientific and geographical societies of London, Paris, Rome and Madrid.

FALL MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY

The fifty-eighth meeting of the American Electrochemical Society will be held in Detroit, Michigan, from September 25 to 27, 1930, with headquarters and registration bureau at the Hotel Statler.

Registration will begin in the evening of September 24, on the ballroom floor of the Hotel Statler, where the registrar will receive arriving members and guests, distribute badges and programs, and give detailed information. Guests should be introduced by members and when registered may attend the sessions and receive such other courtesies as may be extended to them by the local committee or the officers of the society. Local members of other scientific societies, such as the Associated Technical Societies, the Society of Automotive Engineers, the American Chemical Society, the American Institute of Mining and Metallurgical Engineers, the American Electroplaters' Society and the American Institutes of Electrical Engineers and Chemical Engineers, are invited to register as guests without formal introduction.

All scientific and technical sessions will be held in the small banquet room on the ballroom floor of the Hotel Statler. The informal round table discussion on electric furnace gray iron will be held Friday noon, in the large banquet hall. Dr. Richard Moldenke, noted iron metallurgist, will open the discussion.

The electrochemists will visit the plants of the Ford Motor Company, Parke, Davis and Company, Champion Porcelain Company, Hoskins Manufacturing Company, Ternstedt Manufacturing Company and the General Motors Research Laboratories. By special invitation from Mr. Henry Ford, they will have an opportunity to inspect the Ford Village with its unique collection of old machinery and equipment of great historical interest. Leaving the village, they will adjourn to the airport to witness special stunt flying.

At noon, Thursday, there will be an informal luncheon in the large banquet hall in the Hotel Statler and in the evening there will be a theater party. On Friday evening there will be an entertainment on the Canadian shore.

The following persons will present papers in the order given:

Karl Pitschner, Firestone Steel Products Company; D. L. Hippensteel and C. W. Borgmann, Bell Telephone Laboratories; O. W. Storey, C. F. Burgess Laboratories; E. Newberry, University of Cape Town,

South Africa; O. P. Watts, University of Wisconsin; R. J. Wirshing, General Motors Corporation; H. C. Mougey, General Motors Corporation; A. C. Krueger and Louis Kahlenberg, University of Wisconsin; A. H. W. Aten and Miss M. Zieren, University of Amsterdam; Sherlock Swann, Jr., and E. O. Edelmann, University of Illinois; E. Newberry, University of Cape Town, South Africa; M. deK. Thompson and N. Promisel, Massachusetts Institute of Technology; J. E. Lilienfeld, L. W. Appleton and Wm. M. Smith, The Amrad Corporation, Medford Hillside, Mass; Colin G. Fink and Dwight K. Alpern, Columbia University; G. A. Hulett, Princeton University; V. A. Kostjejev, Zagreb, Jugoslavia; Colin G. Fink and Lawrence Greenspan, Columbia University; Colin G. Fink and Wm. M. Grosvenor, Jr., Columbia University; Carl H. Morken, Detroit Electric Furnace Company; L. E. Stout and Jonas Carol, Washington University; Colin G. Fink and K. H. Lah, Columbia University; W. M. Phillips, General Motors Corporation; Colin G. Fink and F. A. Rohrman, Columbia University; L. C. Pan, College of the City of New York; Edward B. Sanigar, Columbia University; Colin G. Fink and Clarence K. Conard, Jr., Columbia University.

THE AMERICAN PUBLIC HEALTH ASSOCIATION

THE fifty-ninth annual meeting of the American Public Health Association will be held in Fort Worth, Texas, from October 27 to 30. The work of preparing the program of sessions and speakers has been going on for months in the headquarters' office of the association in New York City.

Among the speakers will be the president of the American Public Health Association, Dr. A. J. Chesley, who is also commissioner of health of Minnesota, and Hugh S. Cumming, surgeon general of the Public Health Service of the United States, who succeeds Dr. Chesley as president of the association this year. Other prominent speakers who will address the forty-four sessions and preside at the six symposiums are:

Dr. Shirley W. Wynne, commissioner of health of New York City; Dr. Rafael Silva, chief of the department of public health of Mexico City, Mexico; Dr. Gordon Bates, general secretary of the Canadian Social Hygiene Association, of Toronto; Professor John W. M. Bunker, professor of biochemistry and physiology at the Massachusetts Institute of Technology; Dr. W. A. Evans, director of the health department of the Chicago *Tribune;* Dr. W. H. Ross, president of the New York State Medical Society; Dr. H. W. Schoening, Bureau of Animal Industry, Washington, D. C.; Dr. William C. Hassler, health officer and executive officer of San Francisco; Dr. T. F. Murphy, chief statistician for vital statistics, Bureau of the Census, Washington, D. C.; Dr. John A. Farrell, associate director, international health division, Rockefeller Foundation, New York; Dr. John W. Burns, president, Texas State Medical Association; Dr. James A. Hayne, commissioner of health of South Carolina; Dr. Louis I. Dublin, chief statistician of the Metropolitan Life Insurance Company, New York City; John R. Baylis, filtration chemist, department of public works, Chicago; Dr. C. C. Young, director of the laboratories, State Department of Health, Lansing, Michigan; Dr. Joseph C. Bloodgood, chairman of the Maryland Cancer Committee and an outstanding authority on the prevention and cure of cancer; Professor C.-E. A. Winslow, Yale University; Dr. Aristides Agramonte, professor of bacteriology at the University of Havana; Dr. George W. McCoy, director of the National Institute of Health, Washington; Sally Lucas Jean, health consultant, New York City; Dr. W. M. Dickie, secretary of the California Board of Health; Dr. J. G. Cunningham, of the Provincial Board of Health of Ontario, Canada.

Manufacturers of products and equipment used by public health workers have signified their intention of holding exhibits in the Hotel Texas. In Fort Worth there will be a visit to the water filter plant, the new sewage treatment plant, the various hospitals of the city, the Terrell, Globe and Southwestern Laboratories, which will be of particular interest to physicians and bacteriologists, and several unscheduled trips to the city's health centers, day nurseries and schools.

Following the annual meeting of the association in Forth Worth, there will be a nine-day, all-expense tour to Mexico, allowing five days in Mexico City. This has been arranged for association members and their families, in response to an invitation extended to the association by Dr. Rafael Silva, chief of the department of health of the Republic of Mexico, with the approval of the president of Mexico, to visit Mexico City, to meet the public health workers of Mexico and to participate in a scientific program of interest to the American delegates.

A number of allied organizations have made arrangements to hold their meetings at Forth Worth during the convention of the association; among these are the American Association of School Physicians, the International Society of Medical Health Officers, the Association of Women in Public Health, the Conference of State Sanitary Engineers and the Texas Association of Sanitarians.

FIFTH INTERNATIONAL CONGRESS ON AERONAUTICS

ACCORDING to the New York *Times* a proposal for a permanent international committee on aviation was put forward by Dr. J. A. de Vogel, president of the Dutch Society of Aeronautics, in his presidential address opening the fifth International Congress on Aeronautics at The Hague on September 1.

Dr. de Vogel suggested that such a committee should be instituted to give continuity to the work of aero-

nautic congresses. The first section of the congress studied the problem of the organization of airports and the instruments used in aeronautics, including radio.

The experiences of flying in fog and mist and of ice formation on the wings of planes were exchanged. The number of papers read before the technical sections shows that special importance is attached to information of this sort. In the judicial section questions as to insurance responsibility and neutrality in war were taken up.

Several papers on the influence of flying on the human constitution as studied by physicians were read before the medical section. Air sickness was among the disorders discussed.

The official American observers included Major G. E. A. Reitburg, military air attaché at Berlin, Lieutenant Commander G. D. Murray, naval air attaché at London, and A. D. Douglas Cook, assistant trade commissioner at Berlin, all of whom contributed papers to the congress. There were also present John J. Ide, European technical assistant to the National Advisory Committee on Aeronautics; Professor Alexander Klemin, of the Guggenheim Foundation; Dr. W. G. Friedrich, research engineer of Hackensack, N. J., and Clarence M. Young, who addressed the congress on American airway practices.

Sir Sefton Brancker, air vice marshal, headed the official British delegation, which included eight officials of the British Air Ministry.

In the first section of the congress discussion centered on the best way to light air routes and the value of neon light for this purpose. This discussion followed the general lines of the resolutions adopted by the Berlin conference last April. Proposals to be made at the International Congress for Safety in the Air, which will meet in December, were examined, and a small editorial committee will formulate some amendments.

In the medical section standard nomenclature was advocated and discussed, and remedies in regard to sickness among aviators were considered. The air tourist section resolved to formulate a requirement that every town of 10,000 inhabitants shall in some way make its name visible to aviators in flight.

In the judicial section a resolution proposed by a Polish delegate was adopted providing that international conventions on the responsibility of passenger services for the lives of passengers can have no practical effect as long as they are not supplemented by the obligation of air services to insure the lives of passengers up to a maximum of 125,000 francs (about $5,000). This is designed to increase safety measures on the part of air services.

The Italian under-secretary of aviation, Signor Fiannini, proposed a resolution that the unification of laws in aeronautical matters should be furthered as much as possible. The technical section decided to treat meteorological subjects in a special committee of experts, who will meet under the chairmanship of the director of the official Dutch meteorological institutes.

GEOLOGIC SURVEY OF GEORGIA

MR. S. W. McCALLIE, state geologist of Georgia, has announced the beginning of a survey that will require several years for completion and will give Georgia its first complete geologic map, according to a report in the *U. S. Daily*.

Several sectional maps have been made from time to time in Georgia, but the state has lacked a general and comprehensive chart of its geological resources.

Dr. G. W. Crickmay will be in charge of the survey in northern Georgia and Dr. W. S. Bailey, of the University of Illinois, has been retained to assist Dr. Crickmay.

In the southern part of the state, Dr. C. Wythe Cooke, of the United States Geological Survey, will complete this season a map showing the exact location of all classes of rocks and minerals in that section. This work will be coordinated with that in other quarters of the state in compiling the complete chart.

The last available report of commercial minerals in Georgia showed a total value of $16,683,011 for the year 1928, with brick and tile leading in the value of production, and marble and granite next in order. Other valuable minerals listed are bauxite, cement, clay, fullers' earth and manganese.

SCIENTIFIC NOTES AND NEWS

DR. FRANZ BOAS, professor of anthropology at Columbia University, has been elected an honorary member of the Wurzburg Geographical Society.

THE French Astronomical Society has decided to award a medal of honor to the Lowell Observatory at Flagstaff, Arizona, as an expression of appreciation and admiration for the discovery recently made by the observatory of the trans-Neptunian body, preparation for which was made by the learned research of Mr. Lowell.

DR. FRANCIS PENDLETON GAINES, formerly president of Wake Forest College, will be inaugurated as president of Washington and Lee University on October 25.

AMONG the honorary degrees conferred by the University of Liverpool were the following: doctor of laws, Mr. R. L. Mond, honorary secretary to the Davy-Faraday Research Laboratory of the Royal Institution; doctor of science, Professor G. Barger, professor of chemistry in relation to medicine in the University of Edinburgh.

DR. J. S. PLASKETT, director of the Dominion Astrophysical Observatory, has returned to Victoria after a trip through the United States and to England, during which he received the Rumford Medal and the medal of the Royal Astronomical Society.

DR. HANS SACHS, professor of immunology at Heidelberg, and Dr. Ernest Meinicke, of Hagen, Westphalia, have been awarded the Ludwig-Darmstädter Prize with the Paul Ehrlich medal.

THE Bruce Prize of the Royal Society of Edinburgh for the period 1928–30 has been awarded to Mr. N. A. Mackintosh for his researches into the biology of whales in the waters of the Falkland Islands Dependencies. This prize is awarded by a joint committee consisting of representatives from the Royal Society of Edinburgh, the Royal Physical Society and the Royal Scottish Geographical Society.

DR. JEAN CHABRY, Paris, who lost his right arm as a consequence of his early work in radiology, has received the Cross of the Legion of Honor.

M. J. REY has been elected a member of the Paris Academy of Sciences.

PROFESSOR WILLIAM H. WELCH, of Johns Hopkins University, has been elected an honorary member of the Berlin Medical Society.

MR. G. A. SUTHERLAND, principal of Dalton Hall, University of Manchester, and special lecturer in physics in the university, has been invited to be president of the section of acoustics at the twelfth International Congress of Architects at Budapest next September.

DR. F. H. EWERHARDT, of Washington University, was elected president of the American Congress of Physical Therapy for the year 1931–32. Dr. Gustave Kolischer, Chicago, was elected first vice-president; Dr. Luther A. Tarbell, New Haven, second vice-president, Dr. J. S. Hibben, Pasadena, third vice-president, Dr. F. H. Morse, Boston, fourth vice-president, Dr. F. L. Wahrer, Marshalltown, Iowa, secretary, and Dr. John S. Coulter, Chicago, treasurer.

ON September 13 the Reverend Aloysius J. Hogan became president of Fordham University to succeed Reverend William J. Duane, who on July 30 completed his term of six years as the head of the university.

CANON PIERRE DE STRUYCKER, president of the College of Pope Adrian VI, Brussels, is named to be rector of the American College at Louvain, where he was formerly vice rector. He succeeds Monsignor de Becker, who retired after fifty years as a professor.

PROFESSOR C. FLOYD JACKSON, professor of zoology at the University of New Hampshire, has been named dean of the college of liberal arts at the university by President Edward M. Lewis and will assume his new duties immediately. He succeeds Albert N. French, who resigned as head of the college last spring to devote all his time to his work as professor of sociology.

THE school of engineering of the Pennsylvania State College announces that Professor Fred C. Stewart, of the Georgia School of Technology, will take charge of the mechanical laboratory in place of the late Professor C. C. Cochran.

THE new Brooklyn College, which combines the borough's branches of the City College of New York and Hunter College, will open in the near future, with Dr. William A. Boylan, formerly associate superintendent of schools, as president, and Dr. Adelbert G. Fradenburgh as dean of the college. Evening classes will be divided in two divisions as follows: Meta E. Schurtz, assistant director, will have charge of the women's division and James W. Park, also an assistant director, will be in charge of the men's division.

THE following new appointments have been made at Drexel Institute: Mr. Walter Lord Obald, formerly research associate for the Marine Underwriters at the Department of Agriculture, has been appointed assistant professor of biological science; Mr. William E. Mann, instructor in mathematics, and Mr. H. P. Simons, instructor in chemistry.

DR. SAMUEL GELFAN, formerly research fellow in physiology at the University of Chicago, has become assistant professor of physiology and pharmacology at the University of Alberta in Canada.

A. P. BJERREGAARD, until recently chief chemist for the Empire Refineries Division of Cities Service Company and lately doing consulting work, has been appointed professor of chemistry and dean of the science department in the Bryan Memorial University, Dayton, Tennessee.

ALBERT B. STEVENS has become a member of the faculty of the University of Southern California as instructor in general engineering.

DR. KIMBALL YOUNG and Dr. Ralph Linton, formerly associate professors of sociology and social anthropology, respectively, at the University of Wisconsin, have been promoted to full professorships.

ACCORDING to *Nature* the following appointments have been made: At the University of Aberdeen, Dr. James Ritchie, keeper of the natural history department of the Royal Scottish Museum, Edinburgh, to be Regius professor of natural history in succession to Professor J. Arthur Thomson, and Dr. David Campbell, Pollok lecturer in pharmacology and therapeutics in the University of Glasgow, to be Regius professor of materia medica in succession to Professor C. R. Marshall; Dr. R. T. Dunbar, lecturer in physics, to the chair of physics at the University College of South Wales and Monmouthshire, in succession to Professor H. R. Robinson, who has been appointed professor of physics at East London College (University of London), and Dr. John Walton, lecturer in botany in the University of Manchester, to be Regius professor of botany in the University of Glasgow in succession to Professor J. M. F. Drummond, whose resignation takes effect on September 30.

PROFESSOR HENRI ROGER, dean of the Paris School of Medicine since 1912, having retired from active duty on account of age, the council of the faculty has elected as his successor M. Balthazard, professor of legal medicine and director of the medicolegal institute. He received thirty-four votes as against thirty-three cast for M. Roussy, professor of pathologic anatomy and director of the Cancer Institute. The appointment is for seven years.

PROFESSOR V. C. FINCH, professor of geography at the University of Wisconsin, has been appointed a member of the geography division of the National Research Council's science advisory committee.

DR. COOPER CURTICE, veteran parasitologist of the Bureau of Animal Industry, retired from the service on August 31, at the age of seventy-four years.

DR. MALCOLM H. SOULE, associate professor of bacteriology at the University of Michigan, has spent the summer in Europe as United States delegate to the International Congress of Microbiologists at Paris and guest of the Hygienic Institutes at Prague and Warsaw.

DR. ALEXANDER MEIKLEJOHN, chairman of the experimental college at the University of Wisconsin, has been appointed one of the nine American delegates to the International Congress of Philosophers at Oxford.

PROFESSOR PAUL M. LINCOLN, director of the School of Electrical Engineering of Cornell University, has returned to Ithaca from a trip around the world, during which he attended the World Engineering Conference at Yokohama and the World Power Conference at Berlin.

THE following American chemists were appointed by the National Research Council to attend the tenth meeting of the International Union of Pure and Applied Chemistry which was held at Liége, Belgium, from September 14 to 20. Councilors were appointed as follows: Charles L. Reese, consultant, E. I. du Pont de Nemours and Company, Wilmington, Delaware, *chairman* of the delegation; Edward Bartow, professor of chemistry and chemical engineering, State University of Iowa, Iowa City, Iowa; Marston T. Bogert, professor of organic chemistry, Columbia University, New York City; James B. Conant, professor of chemistry, Harvard University, Cambridge, Massachusetts; Austin M. Patterson, professor of chemistry, Antioch College, Yellow Springs, Ohio; Claude S. Hudson, professor of chemistry, U. S. Hygienic Laboratory, Washington, D. C. The following delegates were appointed: C. A. Browne, assistant chief, U. S. Bureau of Chemistry and Soils, Washington, D. C.; J. V. N. Dorr, president, Dorr Company, 247 Park Avenue, New York City; John B. Ekeley, professor of chemistry, University of Colorado, Boulder, Colorado; Gustavus J. Esselen, research and development chemist, Boston, Massachusetts; William Lloyd Evans, professor of chemistry, Ohio State University, Columbus, Ohio; Joel H. Hildebrand, professor of chemistry, University of California, Berkeley, California; J. R. M. Klotz, American Cyanamid Company, 535 Fifth Avenue, New York City; G. M. Norman, technical director, Hercules Powder Company, Inc., Wilmington, Delaware; Alexander Silverman, professor of chemistry, University of Pittsburgh, Pittsburgh, Pennsylvania. Dr. Esselen was also appointed by the council to attend the tenth Congress of Industrial Chemistry held at Liége from September 7 to 13.

THE nineteenth Italian congress for the advancement of science opened at Bolzano, Italy, on September 7. The inaugural address was delivered by Professor Pietro de Francisci. The congress continued until September 10, when it was transferred to Trento, where Guglielmo Marconi made the inaugural speech on "Phenomena Accompanying Radio Transmission." A number of government ministers, including the secretaries of agriculture and of corporations, read papers.

HAMBURG was host from September 7 to 15 to the twenty-fourth International Amerikanisten Congress, members of which are students of all that pertains to America, its history, political and historical, geography, geology, archeology and culture, or research workers in these fields. The following are the most important subjects considered: "The American Indian and His Relations to Other Americans"; "Customs and Habits of the Indians, Their Origin and Extension in the Old and New World"; "The Language of the American Indian, Beginnings of American History. With Especial Consideration of

the Time of Discovery and the First Settlers"; and "Geographical and Geological Problems in Connection with Man's Work." "The Culture of the Indians before Their Contact with Europeans and in the Present" was the main subject of discussion of the congress under the leadership of Professor Dr. Sapper, Wurzburg. The congress will meet in Buenos Ayres in 1932.

THE work of the Philippine Bureau of Agriculture, for the past thirty years charged with the regulation and promotion of agricultural industries in the Philippines, according to the *Experiment Station Record*, has been divided into two parts and assigned to bureaus of plant industry and animal industry. Dr. Manuel Luz Roxas, head of the department of agricultural chemistry of the Philippine College of Agriculture, a 1911 graduate of this institution and a recipient in 1917 of the Ph.D. degree from the University of Wisconsin, has been appointed director of the Bureau of Plant Industry.

DISCUSSION

THE NEED FOR AND THE PROPOSAL OF A NEW GENETIC TERM

A PHASE in the development of genetics which is just getting under way is the analysis of genetic effects over the range of a controllable variable. The data on the effects of temperature upon facet number in the bar series of Drosophila may be quite satisfactorily fitted to the equation $y = ae^{rt}$, in which r is the relative rate of change; t, the temperature in degrees Centigrade; e, the base of the natural logarithms, and a, a constant which gives the value of y, that is, the number of facets when $t = 0$. The first derivative is given by the equation $\frac{dy}{dt} = yr$. Its value at 15° for reverted full females is -21.51 facets. Similar values for bar, ultra-bar and infra-bar females are, respectively, -12.66, -3.76 and $+8.48$ facets. It is held that such values form a better basis for the characterization and analysis of the genetic differences than average facet number, since they take into account at one and the same time not only the number of facets but also the relative rate of change with respect to temperature. From an analysis of the bar series in terms of the first derivative of facet number with respect to temperature new and interesting relations emerge.[1] The point at present, however, is that in such analysis the need is felt for a new term—one to refer to the first derivative of the phenotypic quantity (in this case, facet number) with respect to the controllable variable (temperature).

In analyzing some data on the effect of temperature upon wing-area in homozygous and heterozygous vestigial females it is found that the same equation applies. The value at 30° of the first derivative of wing-area with respect to temperature for long-winged females is -0.0564; for long × vestigial females, -0.0501, and for vestigial females, $+0.0112$ sq. mm. As in the case of the facet-temperature relation, one requires here a term to refer briefly to the first derivative of the wing-area with respect to temperature. As soon as one attempts to speak about the first derivative of such quantities a need is felt for a simple general term.

The convenience and value of a general term for such quantities is well demonstrated by the special terms used for designating the derivatives of various physical quantities with respect to an independent variable, among which may be recalled velocity, acceleration, current, specific heat, modulus, pitch.

In a conversation with Mr. Francis S. Haserot during which several possibilities were discussed he suggested that it might be well to reduce pheno-derivative (abbreviation for phenotypic derivative) simply to *phene*. The following considerations seem to indicate—if the need for such a term be granted—that the situation is perhaps adequately met by the term *phene*. (1) Its relation to the phenotypic expression of the genetic constitution is sufficiently obvious. (2) The nature of the independent variable may be readily indicated by the use of a suitable adjective or prefix, *e.g.*, *thermophene*. (3) That it is but one syllable readily allows for its use in compounds as occasion should arise. Bar facet-thermophene and bar bristle-thermophene clearly distinguish the first derivative with respect to temperature of two different phenotypic quantities on which the bar gene produces an effect. (4) The proposed term allows easy reference to the two related quantities, the first derivative and the original quantity. The inverse of the derivative is the anti-derivative, hence *anti-phene*. For example, the phene for reverted full at 15° is -21.51 facets, and the corresponding anti-phene is 935.4 facets. (5) The word *phene* is not preoccupied, although it happens to be an obsolete chemical term. (6) It is free from any indication of a theoretical interpretation regarding how the genetic factors produce their effects.

In conclusion, the term *phene* is proposed as a word to refer to the first derivative $\frac{dy}{dx}$, in which y is a phenotypic quantity, and x an independent variable. The economy of expression attained by the use of this

[1] A. H. Hersh, "The Facet-temperature Relation in the Bar Series of Drosophila," *Jour. Exp. Zool.* (in press).

term may be indicated as follows: the cumbersome phrase, "first derivative of a phenotypic quantity (facet number, wing-area, etc.) with respect to temperature" is replaced simply by "thermophene."

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THE DETERMINATION OF CARBONATES IN SOIL

IN a recent issue of SCIENCE[1] Schollenberger discusses briefly the error obtained in the determination of carbonates in soil when a strong acid is used as the decomposing agent. He recommends the use of dilute acid and ferrous chloride at a low temperature.

The writer experienced similar difficulty several years ago in the analysis of some Illinois soils.[2] When using 1:1 hydrochloric acid in the Parr apparatus carbon dioxide was obtained from several soils distinctly acid in reaction. Similar results were obtained with sulfuric and phosphoric acids. Nor was the difficulty overcome when the decomposition was carried out at room temperature under reduced pressure. It occurred to the writer that possibly a weak acid should be used in preference to a strong one. Acetic acid was tried with success, no carbon dioxide being liberated from non-carbonate containing acid soils, and in the case of soils containing carbonates a lower value being obtained, the difference being consistent with the amount of carbon dioxide previously found in acid soils when a strong acid was used. No study was made of the causes of the error obtained with strong acids, but it was observed that the error appeared to be independent of the organic matter content of the soil.

Glacial acetic acid diluted 1:1 or 1:2 is used, no other modification in the procedure described by Hopkins[3] being necessary.

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MUSICAL PITCH AND THE PHYSICISTS

I THINK it is time to bring forward once more the desirability of a reform which has long been overdue. I refer to the absurd and unnecessary discrepancy which exists between the usages of the physical and of the musical worlds in the important matter of standard of musical pitch.

For a long time it has been the custom of physicists to make use of a standard of musical pitch based upon a frequency of 256 double vibrations per second for the note middle C, which stands number 40 on the piano keyboard. This frequency actually, however, is rather more than 6 vibrations per second lower than the actual standard frequency of the same note as now universally adopted throughout the United States and in most parts of the civilized world. This latter pitch is usually known as the A440 pitch; that is to say, it is based upon a frequency of 440 D.V.P.S. for the note A which stands number 49 on the piano keyboard. This pitch, or something extremely close to it, has been adopted by virtually all the symphony orchestras of the world, and in consequence by nearly all other musical practitioners, save in France, where the standard still remains the French "normal diapason" of 435 for the same note.

In 1918 the American Federation of Musicians adopted the A440 pitch. In 1925 a committee of the Music Industries Chamber of Commerce, of which I was secretary, representing the manufacturers of every type of musical instrument made in the United States, including the associations of piano, of organ and of wind instrument manufacturers, unanimously recommended that the A440 pitch, based upon a standard tuning fork giving this pitch at a temperature of 68° Fahr., should henceforth be the standard pitch for all musical instruments made in this country. The recommendation was adopted by the directors of the chamber. So far as I know, every manufacturer of pianos, of organs, of wind and of brass instruments in the United States is at this moment using this pitch, which in point of fact represents more nearly than anything else the prevailing standard throughout the world.

As can readily be seen, the discrepancy between this pitch and the entirely artificial pitch used by physicists in their acoustical work becomes extremely serious in the higher regions of the musical scale. Thus, for instance, the note which is represented by 440 D.V.P.S. on the standard scale above mentioned stands at 430.5 on the physicists' scale. In the higher regions the discrepancy is extremely noticeable. Thus, when I sound a fork made on the physicists' scale for the high C, which stands number 76 on the piano keyboard, and compare its sound with that of the same C on our Steinway grand, which is always kept carefully tuned to the 440 standard, the flatness of the tuning fork is extremely obvious and unpleasant, for, as can readily be seen, there is a difference of no less than 44 double vibrations per second. I assume, of course, in both cases, the universal equal tempered systems of tuning.

Instances might be multiplied, but what I have

[1] SCIENCE, 72: 13–14, July 4, 1930.
[2] *Soil Science*, 28: 149, 1929.
[3] C. G. Hopkins, "Soil Fertility and Permanent Agriculture," p. 628, 1910.

said should be sufficient to exemplify the absurdities of the situation. Since the advent of radio engineering and the consequent revival of interest in matters musical among physicists and electrical engineers, the existence of a discrepancy like this becomes extremely important. In most of the scientific papers dealing with acoustical matters in which questions of pitch are taken up, the physicists' scale is used. One is driven to the conclusion that many scientific men are unaware that the scale which they are using is completely artificial and is nowhere used for the practical performance of music.

In matters relating to hearing, to levels of sensation, to discrimination of pitch and to the investigation of musical esthetics, it is obviously essential that all parties to such investigations should speak the same language. It is unfortunate that scientific men and musicians should seem to feel a sort of mutual antagonism, but the fact that their interests are now forcibly merged one with the other ought to bring about some sort of an "entente cordiale" between them.[1] Such consummation is devoutly to be wished for the best interests of the new science of acoustics and for the big practical interests of the recording and reproduction of music. There is not the slightest excuse, save arithmetical convenience, for the persistent use by physicists and engineers of a scale that has not been used for the practical performance of music since the time of Handel. It is high time that when one reads in a scientific paper something about a certain musical note, one should be able to be sure that the writer of the paper means in sound what a pianist, violinist or clarinetist playing that note would actually evoke from his instrument.

I am not alone in the pleas expressed here. Dr. Dayton C. Miller, one of the greatest of American pioneers in the science of musical acoustics, long since called attention to the absurdities which I have ventured to describe once more. In his book "The Science of Musical Sounds," published in 1916, he devotes some space to the discrepancy mentioned, and makes a plea for uniformity and common sense.

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PHYSIOLOGY OF RARE GASES

It is to be hoped that the article of Professor Hershey in Science of April 11 last on the "Components of Air in Relation to Animal Life" will command some attention. The idea that the rare gas fraction of the atmosphere has some physiological significance has had a great attraction for me during the past ten years, and as far as my acquaintance with the literature goes, Professor Hershey's work is outstanding in its direct bearing on the subject. The experiments of McDonald and Kellas,[1] Kellas,[2] Tolomei,[3] Regnard and Schlösing,[4] Zaleski,[5] Marcacci,[6] Cannon and Free,[7] Pictet, Scherrer and Helfer[8] and Hackspill, Rollet and Nicloux[9] when taken together have given no decisive answer to such a question.

In describing the results of experiments with nitrogen-oxygen mixtures, Professor Hershey was led to remark that "the rare gases seem to play a part in normal life equally as important as oxygen." On the other hand, when in the nitrogen-oxygen mixtures the latter gas was increased to a proportion of from 25 to 40 per cent., "the animals appeared to be normal and in a few cases better than in normal air." This leads to an inference that an apparent compensation for the absence of the rare gases was accomplished by an increase in oxygen and reciprocal decrease in nitrogen within certain limits.

Since in the complete absence of oxygen the duration of animal life is only a matter of minutes, while in certain mixtures of nitrogen and oxygen with an absence of the rare gases the duration was at least three weeks, the importance of these rare gases does not appear to be vital in the absolute sense unless a longer period of time is required for the demonstration. It may be, therefore, that we are presented with an analogy to the food requirements of the animal organism, where the bulky part or roughage corresponds with the nitrogen, the caloric value with the oxygen and the accessory food factors with the rare gases. Vitamin deficiency takes a much longer time to injure health and end life than the complete withdrawal of food. It may be possible too that the food is itself a means of compensation or source of error, for Tolomei's contribution to the problem was to show that argon is locked up in the root tubercles of legumes which are associated with nitrifying bacteria. In judging of a state of health that is "better than normal," general appearances must be considered, but without some quantitative guide, such as size and weight or rate of growth of the young, one must be wary. The slight flush and bright eye of a low fever may improve the appearance of the human being though he be impaired in health.

1 "The Gases of the Atmosphere," Ramsay.
2 *Proc. Roy. Soc.*, 59: 66.
3 Chem. Cent. I, 1030 (abstract).
4 *C. r. Acad. Sci.*, 124: 302.
5 *B. Dtsch. Chem. Ges.*, 30: 965.
6 *Mem. R. Ist. Lomb. Sc. e Lett., Sc. Mat. e Nat.*, 19–20, Ser. 3.
7 Carnegie Inst. Yr. Bk., 20, 63.
8 *Helv. Chim. Acta*, 8: 537.
9 *C. r. Acad. Sci.*, 182: 719.

It is evident that long-continued experiments may be necessary, and in the case of specific mixtures of gases requiring the complete absence of the rare gases or their presence in definite proportions, the apparatus may become complicated and the technique very exacting, especially when any record is to be kept of metabolic changes. For some purposes a closed circuit is a necessity, and I am not sure but that such a system introduces some complicating conditions, possibly by gas adsorption upon walls or materials or by the cutting down of radiant energy from without. In my own efforts,[10] for example, results soon led from experiments with nitrogen-oxygen mixtures to a closer examination of what happened to animals when confined in a circuit of ordinary air. Frogs were the most convenient animals to use, and there was disclosed a peculiar fluctuation in the nitrogen-rare gas fraction of air which was apparently correlated with light and darkness.

It is the relative proportions of the various gases in an atmosphere that seems to me to be a matter of prime importance, and this is clearly indicated in Professor Hershey's experiments. The necessity for accurate gas analysis led me to discontinue respiration experiments in 1924 in order to develop an apparatus for the analysis of air samples in which the "inert" fraction could also be determined. As soon as attempts were made to increase accuracy, irregularities began to appear with such persistence that it seems possible that differences as low as .01 per cent. in oxygen estimations may have some significance other than technical error. The associated gases may, perhaps, play some part, for irregularities tended to be greater when using oxygen made by the liquid air process where the argon impurity was about 1.9 per cent. Results are still very confusing, but an anomaly seems to be developing which must be more clearly defined before reporting. That these irregularities are due to an isotope may be possible. The magnitude of change is such as to be perhaps too frequently ascribed to experimental error and on that account keeps the observer in a harassed state of mind.

The main object of this note is to give a word of praise and encouragement for these experiments of Professor Hershey. One of the chief difficulties in arousing interest in and support for such work is to present any reasonable mechanism by which the "inactive" gases may act upon the body. The possibility of finding a mechanism in the field of gas analysis has kept me away from the more physiological type of respiration experiment. While medical men may understand little concerning the rare gases, as Professor Hershey suggests, I have a suspicion that the chemist and physicist are likewise ignorant of some important relation between these noble gases and the commoner constituents of the atmosphere.

EDWARD FIDLAR

SCIENTIFIC BOOKS

Manual of Meteorology, Vol. III. *The Physical Processes of Weather.* By SIR NAPIER SHAW, F.R.S., sometime director of the Meteorological Office, London, and president of the International Meteorological Committee. With the assistance of Elaine Austin, formerly of Newnham College, Cambridge. Cambridge University Press. American agent, Macmillan. 445 pages, 149 figures. Price $9.00.

THIS being an air-minded (not *aero*-minded) age with airports (not *aero*ports) and aviation instruction schools advertised by every ambitious town, we would expect to find airgraphics (not *aero*graphics) holding a prominent place in the curricula of our colleges and universities. Such is far from reality. Worse yet, no one feels responsible. Physicists are indifferent; engineers, not excluding aeronautical engineers, feel it is not up to them; chemists, biologists, geologists and even economists give themselves no concern, content perhaps with a daily weather map. Yet in every field of scientific endeavor, varying atmospheric conditions have direct and noticeable effects. We do not see how precise measurements, for example, can be made when only casual uncorrected readings of pressure and temperature are made.

By airgraphics we mean just what the word says, the science of the air, the description in full of atmospheric phenomena. It is more than the physics of meteorology, or the statistical methods of climatology, being in brief the detailed study of the earth's gas envelope, regarded as a tremendous thermal engine, with energy transformations of heat and motion. Sir Napier Shaw, retiring from a long and proved leadership of the Meteorological Office, set himself the heavy task of collating all that had been done in atmospheric physics and dynamics by divers workers in many lands, and seen from different angles. This has long been miscalled meteorology. (In the present volume [III] meteors are mentioned twice. In Vol. II there are two scant references, and in Vol. I, one.)

Vol. I, it will be recalled, gave a general survey of the atmosphere; Vol. II dealt with the physics of the air. The present volume (III) sets forth the dynamics and thermodynamics of circulation. Vol. IV has had a curious history, illustrating that the last shall be first, for it was issued in 1919 and dealt with the wind

[10] Univ. Toronto Studies, Physiol. Series No. 98.

as connected with pressure distribution. We are given to understand that a new Vol. IV is on the stocks, for the double reason that the first issue is already out of print and that there is so much to be added.

Individual effort could hardly accomplish such monumental work and Sir Napier acknowledges fully the ready cooperation of many former official associates, and others, not forgetting proof-readers, pressmen, binders and the manager of the University Press. We take it that all felt a measure of pride in the making of these volumes.

There is not space here to discuss at length new material. One matter of great moment is the practical application of entropy—that elusive something connected with the degradation of heat which college instructors despair of ever explaining lucidly to their classes. It is here regarded as "an index of the dilution of the energy of the working air." In fact, the whole of Chapter VI, treating of "Air as Worker," is a piece of straight thinking on a difficult subject. His tephigram (a combination of temperature and entropy) enables one to plot the heights of successive isentropic surfaces. We are given tables for calculating the entropy of the air, when temperature and pressure are available. We can now regard "an *isentropic surface* as a practical alternative for sea-level or some other *horizontal* surface on which to place the facts about the weather."

Sir Napier of course is a master hand at good English. The nine-page comment on the analogy of medicine and meteorology could well be reprinted as a separate, making a delightful little essay requiring only fifteen minutes to read, but inspiring hours of thinking over. A few lines will make this clear.

> We might indeed have profited by the analogy to which we have drawn attention by giving to this volume the title "The Physiology of Weather," as defining the attitude which meteorologists have to adopt towards experimental physics. We have felt however that to do so might convey the impression that we were proposing to regard weather as the expression of a living organism. Although the weather has many characteristics that are suggestive of vitality, we have thought it best to avoid that impression.

Any forecaster of long experience will appreciate the implication that the weather has a will of its own and like old Joey is deep and devilish sly!

And acknowledging the impeachment that he is not a text-book writer, *i.e.*, one who saves students the trouble of thinking, it is suggested that comprised within the almost unpronounceable name of meteorology there are a large number of subjects quite worth while thinking about. It is in a way unfortunate that the science has been to some extent accepted as a responsibility of government, and this perhaps accounts for much of the indifference of universities, as mentioned above.

It only remains to say that we wonder why a Nobel prize has not come to Sir Napier Shaw. We hope that such recognition will not be much longer withheld.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE RATE OF GROWTH OF STALACTITES[1]

IN the summer of 1929 the writer observed stalactites suspended from the roof of the inspection tunnel in the Wilson Dam at Muscle Shoals, Alabama, and later a series of specimens was collected for him by Captain H. D. W. Riley, of the Corps of Engineers. These stalactites are of more than ordinary interest, as their age is known and their rate of growth can be approximately determined.

Fig. 1 is a generalized sketch section of the Wilson Dam. The inspection tunnel is near the base of the dam on the upstream side, its floor 90 feet below the surface of the impounded pool. It is 6 by 9 feet in section and 4,600 feet long. In it are located the valves of the wells for the relief of accumulated hydrostatic pressure in the bedrock beneath the dam. The stalactites hang from the roof of the tunnel along the lines of junction of adjacent concrete segments.

[1] Published by permission of the director of the U. S. Geological Survey.

Most of the stalactites ranged between 5 and 9 inches in length (12.7 and 22.8 centimeters) and the

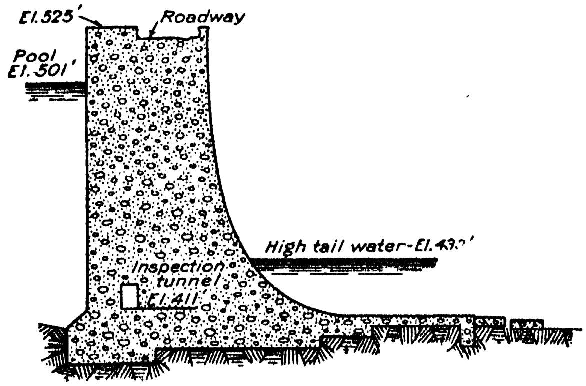

FIG. 1. Cross-section of Wilson Dam at Muscle Shoals, Alabama. The stalactites hang from the roof of the inspection tunnel, eighty-one feet below the surface of the pool.

longest observed was 15.2 inches (38.7 centimeters). The average diameter near the tip was 0.2 inch (0.5 centimeter), and at the base the diameter ranged between 0.5 and 1.5 inches (1.2 and 3.8 centimeters). All had the form of hollow cylindrical tubes whose walls increased in thickness from the tip toward the point of attachment. With two or three exceptions the stalactites were symmetrical.

Impounding of the reservoir was accomplished early in 1925, and the stalactites were measured early in 1930 so that their present size represents five years' growth. Roughly the linear growth rate of the average specimens was between 1 and 2 inches a year. As pointed out by Allison,[2] the factors affecting stalactitic growth are rate of drip, air circulation, relative humidity, temperature and concentration of the mineral content of the water. As each of these factors has a wide range in different places, it is obvious that the rate of stalactitic growth in the Wilson Dam inspection tunnel is peculiar to the exact conditions there prevailing and is not generally applicable.

Recently Mr. F. E. Matthes, of the U. S. Geological Survey, showed the writer a tubular stalactite 3.5 inches (8.9 centimeters) long, 0.5 inch (1.3 centimeters) in diameter at the base and 0.25 inch (0.6 centimeter) at the tip, which he had collected from the arch of a concrete culvert in Rock Creek Park in Washington. The culvert was constructed in 1927, and the stalactite had attained the dimensions given two years later.

In connection with the stalactites already described two exhibits at the National Museum are of interest. One (U. S. N. M. No. 39089) is a group of tubular stalactites 0.5 inch (1.3 centimeters) in diameter and 4 inches (10.2 centimeters) long, which were formed under one of the old arches at the west side of the center of the Capitol. Although the time of formation is not exactly known, it is on the order of tens rather than hundreds of years.

A second exhibit (U. S. N. M. No. 68342) is a pint whisky bottle which was left for five years under a small drip in Weyers Cave, near Shenandoah, Virginia. The bottle is coated with a crust of calcium carbonate which has a maximum thickness of 0.25 inch (0.6 centimeter).

Allison[2] noted stalactites in a coal mine growing at the rate of 0.1 to 1.44 centimeters in length a month. Curtis[3] observed aragonite aggregates growing in drops of water at the rate of $\frac{3}{8}$ inch in three months. Mr. E. T. McKnight,[4] of the U. S. Geological Survey, observed calcium carbonate stalactites as much as 2 feet in length and several inches in diameter suspended from old timbers in a lead mine in Arkansas. The maximum age of these stalactites is probably 30 years.

The observations cited indicate that the formation of stalactitic and stalagmitic deposits of calcium carbonate in caves can proceed at a fairly rapid rate when the essential conditions are favorable.

More soluble salts permit greater concentration of the solutions, and stalactites of such salts often grow very rapidly. A copper sulfate stalactite 27 inches (67.5 centimeters) long and 1 inch (2.5 centimeters) in average diameter on the 1,400-foot level of the Briggs mine, at Bisbee, Arizona, was formed in 17 months.[5] On the assumption that the conditions were constant this represents a rate of 1.68 inches (3.95 centimeters) a month. Photographs showing the stalactites of chalcanthite and limonite hanging from mine timbers at Butte, Montana, have been widely reproduced.[6]

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U. S. Geological Survey

[2] V. C. Allison, "The Growth of Stalagmites and Stalactites," *Jour. Geology*, 31: 106–125, 1923.

[3] J. S. Curtis, "Silver-lead Deposits of Eureka, Nevada," U. S. Geol. Survey Mono. 7, pp. 56–58, 1884.

[4] Oral communication.

[5] G. J. Mitchell, "Rate of Formation of Copper Sulfate Stalactites," *Am. Inst. Min. Eng. Trans.*, 66: 64, 1921.

[6] W. H. Weed, "Geology and Ore Deposits of the Butte District, Montana," U. S. Geol. Survey Prof. Paper 74, pl. 8, 1912.

BLACK PAPER FOR CAMERA LUCIDA DRAWINGS

In the use of the camera lucida some difficulty is frequently experienced in seeing clearly the object when white drawing paper is used.

Quite accidentally, the writer discovered that the object stands out much more definitely when a black surface is the drawing medium.

Black drawing paper (charcoal paper) may be secured in any store that carries a good line of drawing materials, and it is very satisfactory. Some difficulty was experienced in getting a pencil that was, in the first place, hard enough to take a good point, and, in the second place, of a color that would stand out well on a black background. An Eversharp carrying yellow lead was found best for the purpose. This lead can be sharpened to a needle point on fine sandpaper and is sufficiently hard to hold this point.

A controllable source of illumination on the drawing paper has been found beneficial in making the point of the pencil stand out more clearly. This is particularly true if the work is being done in a dark room or at night.

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SPECIAL ARTICLES

GEOGRAPHICAL INDEX NUMBERS

THE term geographical index number is a mathematical expression intended to represent the intensity of man's utilization of the environment or, as some would say, the quantitative determination of a geographical relationship. A hypothesis is established that a complete harmony between man and environment or a maximum geographical relationship has an index value of 100. Thus, in computing the geographical index numbers, the object is to determine and express in the form of a ratio what man is doing with what he should do in order to utilize most efficiently the environment. The word utilization is here defined to include the thought of control, adaptation or use of the environment.

Quite evidently, any attempt to measure quantitatively such variable components as man and environment is subject to conjecture. In fact, the supposition may seem unscientific because, in the opinion of some students, the nature of a geographical relationship or man's utilization of the environment will not lend itself to classification. The probable error of such quantitative determinations has been referred to as being so high that the results are scarcely more than personal judgments. These assertions may apply to the methodology or technique of measuring geographical relationships, but they do not exclude the possibilities of solving the problem within the limits of the probable error.

Apparently there has been very little attention directed towards quantitative analysis or synthesis of the reciprocal relationships between man and environment, if one can judge from known literature and discussions. The science has not advanced far beyond the descriptive stage—a situation, however, that does not reduce the significance of index numbers. In other social sciences, particularly economics, index numbers have a potent position. This should be equally true in geography. The effort to determine quantitatively the relationships between human activities and their settings represents time well spent, regardless of results. It fosters a greater interest in the classification, correlation, interpretation and application of geographical data, thus placing geography in the realm of a true science. The concentration of factors involved in a geographical relationship into one mathematical expression or figure necessitates careful weighing of the individual factors both human and environmental. The results are likely to be more representative and less misleading than when the same geographical relationship is expressed in a lengthy dissertation. Another salient feature of index numbers is their adaptability to maps. Geographical index numbers can be easily placed on maps, thus disclosing the nature of the environmental elements which in many cases can not be shown on one map. Through the addition of geographical index numbers physical maps may be converted into geographical maps.

The method of procedure in the determination of the geographical index number is as follows. In formula $\text{G. I. N.} = \frac{U^d \times 100}{U^m}$, G. I. N. represents the geographical index number; U^d represents present degree or intensity of utilization, and U^m represents maximum degree or intensity of utilization.

The values of U^d and U^m are expressed in terms of digits 1 to 10. Since the digit value of the maximum degree of utilization equals 100 per cent. the formula may be expressed in the form of a ratio as:

U^m (maximum utilization) : $100 = U^d$ (present utilization) : X (geographical index number).

The digit value of U^d and U^m are determined from the following expressions:

$$U^d = A^d \times P^d \text{ and } U^m = A^m \times P^m$$

(m) represents maximum
(d) " present degree
(P) " productivity
(A) " activity

Let us apply these equations to a given field in which the cultivation of corn is the major form of activity. A careful analysis of the human factors involved in the utilization of said field, such as method of cultivation, equipment, market conditions and transportation facilities, show that they have a digit value of 6. That is, each one of the human factors is graded on the basis of 1 to 10 as to degree of efficiency. Then the digit values of all human factors are added and the average determined. If the human side of the equation in the above illustration had been recognized as excellent then the digit value would have been recorded as 10. Thus the component (A^d), present activity, has a digit value of 6 in expression $U^d = A^d \times P^d$.

In the determination of (P^d), present productivity, such physical factors as soils, topography, climate and biological elements, and such locational factors as position, area and distance, are considered with reference to the growing of corn in the above illustration. The digit value of the physical factors is determined on a basis similar to that used in the determination of the human factors. The results show that the digit value of the physical factors is 8. Again, if the

conditions had been ideal for the production of corn the digit value would have been 10.

Since $U^d = A^d \times P^d$, $\therefore U^d = 6 \times 8 = 48$; that is, the present degree of utilization of said field has a digit value of 48.

The next step in the determination of the geographical index number is to consider the digit value of the maximum degree of utilization. It may be repeated for the purpose of clearness that the most efficient utilization of a given area is recognized as the maximum utilization or geographical relationship. Again, referring to the above illustration, let us suppose that (A) activity has a digit value of 10 if cotton is grown, while the digit value for corn as stated above is 6. Thus the (A^m) maximum activity has a digit value of 10. It is also assumed the component (P) has a digit value of 10 for cotton and only 8 for corn. Thus, the (P^m) maximum productivity has a digit value of 10.

Since $U^m = A^m \times P^m$, $\therefore U^m = 10 \times 10 = 100$. In other words, it is much more advisable so far as the geographical relationship is concerned to grow cotton than corn because the digit value for corn is 48 as compared to 100 for cotton.

In completing the formula, $G.\ I.\ N. = \frac{U^d \times 100}{U^m}$ or $= \frac{48 \times 100}{100} = 48$. Thus the geographical index number for the given field is 48. (It should be kept in mind that the digit value of the maximum utilization is always equal to 100 per cent and that a maximum geographical relationship is 100.)

The question undoubtedly comes to the reader as to how the digit values are determined. Are they largely personal estimates? However, after a careful consideration of maps, statistics, field work and consultation with specialists in the respective sciences the problem assumes a tone of encouragement. The satisfaction reaches the point where the results are above estimates, at least, more than personal opinions. As previously stated the attempt to place on a quantitative basis the factors involved is a worthy step towards the establishment of geography as a true science.

Another query about geographical index numbers pertains to the difficulty of determining what shall be recognized as the most efficient use of the land. Shall it be considered from the interests of an individual, a community, a state, a nation or society as the human race? With the tendency to consider geography as chorography, or a study of regions, it may be safe to say that the degree of utilization should be considered from the point of view of the occupants of the accepted region. There may be reasons at times to consider the problem from the interests of the individual or even nations. It all depends upon the objective.

In conclusion it may be said that geographical index numbers are intended to show the intensity of man's utilization of the environment or the geographical relationship. A low geographical index number suggests inefficient use of the environment. It may be the reader's interest to determine why a given region or area is not more effectively utilized. Areas of low geographical index numbers should disclose the future lands for human occupancy if the index numbers fulfil their purpose. Indeed, it is not assumed that it is always advisable for man to use his environs most efficiently. In other words, there are factors other than those classified as geographic that enter into the activities of man. Geography is not a science of determinism.

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OVERWINTERING OF THE FIRE BLIGHT PATHOGEN, BACILLUS AMYLOVORUS, WITHIN THE BEEHIVE[1]

IN a former article[2] the writer discussed the pioneer work of Merton B. Waite, who showed that the honey-bee is capable of acting as a carrier for the fire blight germ. Waite, as is well known, produced artificial epidemics of blossom blight by inoculating pear blossoms with pure cultures and then noting the relationship of bees in disseminating the pathogen from inoculated or diseased blooms to healthy ones.

Following Waite's work it has been commonly assumed that under natural conditions bees and other insects obtain the inoculum from drops of ooze or exudate that are extruded in the early spring from blight cankers located on diseased trees. In other words, while Waite had presented no evidence to show that under field conditions the insects obtain the inoculum from bacterial exudate originating in overwintered cankers, his findings of bacterial dissemination by bees from artificial infections has been used as a basis for the assumption that bees and other insects obtain the inoculum from oozing cankers. And, notwithstanding the fact that Waite[3] in his later articles makes no mention of bees as visitors or disseminators of primary inoculum from exuding cankers, though mentioning wasps and flies as acting in this capacity in one of his articles (a theory of Waite's for which no proof has been presented), it has been almost universally assumed up until recently

[1] Research paper No. 209, Journal series, University of Arkansas.

[2] SCIENCE, 70: 355, 1929.

[3] *Trans.* N. Y. State Agr. Soc., 1897: 779–790, 1898. Thirty-first Fruit Growers Conv. State Cal., 1905: 137–155, 1906. *Proc.* W. Va. State Hort. Soc., 1911: 66–73, 1912.

that bees and other insects, chiefly pollinating and nectar-seeking ones, obtain infectious material from "holdover" blight and spread it to the newly developed bloom. In accordance with this assumption the removal of blighted limbs from infected trees has been the main recommendation, often the only one, for controlling this disease.

Beginning with the observations of Stevens and his associates[4] in 1918 on the dissemination of the blight-producing pathogen by wind, there have been a number of investigators who have questioned the rôle of insects either in disseminating the blight producer after the disease started[5] or as agents of initial dissemination,[6] and some excellent evidence has been presented to show that rain falling over exuding cankers may readily act as a disseminating agent. But so far as the writer knows no concerted effort has been made by these investigators to explain the fact that, with relatively few exceptions, the first signs of blight in bearing orchards are to be found usually in the blossom clusters. Inasmuch as several investigators have presented rather conclusive evidence showing that young pear and apple leaves may readily be infected through natural openings by means of water suspensions of the pathogen, why then are the foliar shoots relatively free from disease in an orchard where they develop simultaneously with the bloom and where the latter may show a high percentage of infection?

It is this question plus one other consideration which has made it appear worth while to investigate the source of inoculum which may be involved in the first spring infections. The other consideration arose from the fact that no infectious exudate from overwintered cankers has been found to occur in the Ozarks of Arkansas prior to the first signs of blight, as reported in a previous publication.[7]

Aside from the overwintering of fire blight bacteria within twigs and limbs which were diseased the previous year, there are several other possible sources of overwintered inoculum. Among these are, first, bacterial masses freed as exudate during the previous growing season and remaining alive over winter, or bacteria freed by the disintegration of formerly diseased material, including leaves, succulent and woody shoots, flowers and fruits; second, the carrying over winter of the germ within the living quarters of insects which had previously come in contact with diseased material, or the adherence of the bacteria directly on the insect bodies. Indicative of the first possibility, evidence has been obtained which suggests that this may be true but which at this time is considered to be inconclusive. For the present it may suffice to note that certain strains of bacteria of proved pathogenicity have been isolated in the early spring from diseased material, strains which morphologically and physiologically are markedly different from the ordinary ones of *Bacillus amylovorus.*

Considering the second possibility, the writer has successfully isolated the fire blight pathogen from beehive material gathered throughout the summer, winter and early spring and from the bees themselves obtained from the hives in the early spring prior to the development of blight. The details of this work will be reported elsewhere. It may be stated that technique of isolation is extremely important in this instance. There remains to be determined, however, whether these findings are applicable to various sections of the country, and under diverse climatic conditions.

In the meantime it appears likely that we now have an explanation for the common occurrence of blossom blight in the absence of twig blight and in the absence of early spring oozing from blighted twigs and limbs. It is also probable that an explanation is at hand for the failures to control blight in orchards where painstaking, current remedial methods have been used, including the removal of blighted wood.

As a matter of caution it should be noted that even if the present findings will be duplicated in different parts of the country this does not mean that bees can be dispensed with. As long as self-sterile pears and apples are grown, these insects seem essential for proper pollination. The problem of control involves, among other things, the maintenance of uninfested beehives, and the failure to recognize this must at least in part account for the gradual extinction of the pear industry in America.

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[4] SCIENCE, 48: 449–450, 1918.
[5] *Ohio Agr. Exp. Sta. Bul.*, 357: 83-126, 1922; *Mich. Agr. Exp. Sta. Tech. Bul.*, 97, 32 pp., 1929.
[6] *Jour. Agr. Res.*, 39: 579–621, 1929.
[7] *Ark. Agr. Exp. Sta. Bul.*, 244, 96 pp., 1929.

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THE ETHER CONCEPT IN MODERN PHYSICS[1]

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I HAVE felt it would be safe to assume that the ether concept is a subject of interest to the workers in all scientific fields. As a matter of fact, it must be a matter of concern to all thinking people, since it has to do with some of the greatest of those forces of nature upon which depend the comfort, the happiness and, indeed, the very existence of the human race.

It is not here implied that a knowledge of this or, for that matter, of any physical theory is essential to man's existence; but it will be conceded, I think, that knowledge of this sort may contribute greatly to his comfort and happiness.

To have one's interest in this question aroused it would perhaps be sufficient to be reminded that the ether theory attempts among other things to explain the machinery by means of which heat and light are transmitted through regions devoid of ordinary matter—the radiant energy, for example, which comes to us from the sun across more than ninety millions of miles of empty space. It is, of course, this unbroken stream of energy which pouring upon the surface of the earth makes possible here all the varied forms of life, and the study of life, together with its conditions and environments, is directly or indirectly the ultimate objective of all branches of physical and biological science.

The first use of the ether concept is shrouded in the haze of the fragmentary records of antiquity. In more recent times, for which the records are more complete, it has had a strange and checkered history and for centuries in scientific discussions it has been a subject of bitter controversy.

The theory that space is filled by an all-pervading medium having properties unlike those of ordinary matter was for a time quite generally accepted. Later on, it was rejected and all but forgotten. It was afterwards revived and strengthened and brought

[1] Address of the president, forty-fourth annual meeting of the Iowa Academy of Science, Ames, Iowa, May 2, 1930.

to a high place in scientific thought—only once more to fall into serious question. At the present time it struggles for existence but it shows signs of surviving and gives promise of continuing for a long time to come. It is doubtful if man in his thinking can ever dispense with it altogether.

To be sure, there are scientists of to-day, as there always were in the generations past, who profess to have no need for the ether hypothesis; but curiously enough there is usually collateral evidence that these same philosophers make use of it in their thinking, however studiously they may avoid any reference to it in their speech.

The widely accepted pronouncement that "truth crushed to earth will rise again" carries with it, as a sort of corollary, the implication that in man's search for truth a recurring theory must have in it the elements, at least, of conformity to fact. The very circumstance of its return, after temporary overthrow, to a high place in scientific thought argues for some sort of relationship to truth.

The astounding history of the ether concept—of its rise and fall, its resurrection and its continuing power—is probably without parallel in the records of the scientific world.

I invite you to a brief consideration of the ether concept, directing your attention particularly to its rise and development, to some of its shortcomings and to its more important implications.

The writings of St. Thomas Aquinas, whom we may regard as the spokesman of the religio-scientific thinkers of the thirteenth century, indicate a general acceptance at that time of the Ptolemaic system of astronomy. This system was founded upon the assumption that as "man was the object of creation, so the earth was the center of the universe, and around it revolved concentric spheres of air, aether, and fire—'the flaming walls of the world'—which carried round the sun, stars and planets."[2]

This early history is mentioned partly in preparation for that which follows and partly to show that an ether concept was in use at this period. It should be noted, however, that this "aether" is not an all-pervading medium. It composes one of the concentric spheres and is, therefore, in form a spherical shell.

Two hundred years later, after the work of Copernicus and Galileo had overthrown the geocentric theory of the universe, and the hypothesis of the crystalline spheres as the carriers of celestial bodies had been abandoned, it became necessary to find a way to account for the motion of the planets.

The first conspicuous attempt to do this was made in the middle of the seventeenth century by Descartes in his celebrated vortex theory. This theory assumes that interplanetary spaces are occupied by a plenum which is filled with great vortices. In these plenum vortices the planets and their satellites are carried. The sun is at the center of an immense vortex which carries the planets, and each planet the center of another vortex accounting for the motion of the planet's satellites. Thus the plenum is formed into vortices of varying size and velocity, and it is assumed that a celestial body in any such vortex, being slower and less subject to centrifugal action, is forced toward the vortex center.

Descartes' theory is not considered comparable in importance with those of Ptolemy or Copernicus, largely perhaps because it apparently led to no new discoveries; but it was rated of considerable importance in philosophy because it constituted an attempt at a mechanical explanation of the universe. It is interesting to note that it survived for a century or more in advanced scientific thought and teaching, not alone in France, but in England and America as well. It is recorded that an English translation of Descartes' treatise was in use as a text-book in Yale College as late as 1743—long after the publication of Newton's work which pointed out the inconsistencies of the vortex theory.

As we have seen, the first important use of the ether concept was in an attempt to account for planetary motion and to explain the structure of the universe. It was next employed by Hooke and Huygens toward the end of the seventeenth century (1678) to explain the transmission of light. Descartes too, as a matter of fact, had held that light is a pressure transmitted through his plenum of space.

Thus we see that again the assumption is made that there is a non-material medium which fills all space, the medium this time being particularly characterized by the property that luminous bodies have the power to set up wave motion within it. This is the luminiferous ether, and under this ether theory light is a wave phenomenon.

Newton professed to be unable to accept the theory of the luminiferous ether on this basis, chiefly because he believed it failed to explain in a satisfactory way the fact that light travels in straight lines. He taught that straight line motion is natural to moving *bodies,* and it is easy to understand the appeal of the corpuscular theory to him on this score. He says in Query 29 of his "Opticks," "Are not the Rays of Light very small Bodies emitted from shining substances? For such Bodies will pass through uniform mediums in right Lines without bending into the Shadow which is the nature of the Rays of Light."

The seventeenth century witnessed a conflict between these two theories of light. "Newton from facts then known balanced the arguments for and against each

[2] Dampier-Whetham, "A History of Science," p. 96.

theory, and hesitatingly decided in favor of the emission theory, while on the continent his great contemporary Huygens advocated the wave theory."

Concerning this conflict S. P. Langley said:

These two great men, then, each looked around in the darkness as far as his light carried him. All beyond that was chance to each; and fate willed that Newton, whose light shone farther than his rival's, found it extended just far enough to show the entrance to the wrong way. He reaches the conclusion that we all know; one not only wrong in regard to light but which bears pernicious results on the whole theory of heat, since light, being conceded to be material, radiant heat, if affiliated to light, must be regarded as material too; and Newton's influence is so permanent, that we shall see this strange conclusion drawn by the contemporaries of Herschel from his experiments made a hundred years later. It would seem then that the result of this unhappy corpuscular theory was more far-reaching than we commonly suppose.[3]

This comment of Langley's was written about forty years ago, at a time when the wave theory was quite universally accepted. Now it is thought by many that Newton in adopting the corpuscular theory of light denied the existence of the ether. But this is far from the truth, as his own writings unmistakably show. To illustrate, in offering an explanation under the corpuscular theory of the fact that a transparent body, a sheet of glass for example, can at the same time reflect and refract, he considers that the corpuscles are subject to "fits of easy reflection and easy transmission" communicated to these particles by undulations in an all-pervading ether. The ether at the surface of the body, agitated by the flying particles, is alternately compressed and rarefied, and a particle at the surface in a compression is thrown back, whereas in a rarefaction it passes through. Other references, particularly in the "Queries," are equally illuminating. The significant fact just here is that even Newton, the most distinguished opponent of the wave theory of light, found it necessary in his thinking to employ the ether concept.

It came about then, that notwithstanding the very able defense of the undulatory theory by Hooke, Huygens and others, and largely because of Newton's overpowering authority, the corpuscular hypothesis rose in power and for a long time remained in the ascendancy. Cajori states that "the only prominent writers of the eighteenth century who advocated the undulatory theory were Leonard Euler and Benjamin Franklin."[4]

At the beginning of the nineteenth century (1801), Thomas Young after a study of the colors of thin plates, the familiar soap-bubble colors, declared himself in favor of the wave theory for the following reasons. These colors are explained under other theories only with greatest difficulty and by the aid of most gratuitous assumptions, whereas "the minutest particulars of these phenomena are not only perfectly consistent with the [wave] theory . . . but . . . they are all the necessary consequences of that theory, without any auxiliary suppositions."[5]

Some years later (1815) Fresnel became strongly convinced of the truth of the wave theory, and deeply impressed by its power to explain transmission, he succeeded in accounting for rectilinear propagation on the wave theory basis, and also explained more fully two other troublesome matters, namely, diffraction and interference. As a result of the work of Young and Fresnel, there once more arose a bitter contest between the advocates of the opposing theories of light.

Just at the middle of the century (1850) came the experiments of Fizeau and Foucault and their so-called laboratory methods for measuring the velocity of light. These methods made it possible to put to the test the old controversy as to whether light travels faster or slower in a denser medium. The corpuscular theory demanded a faster, the wave theory a slower speed in the denser medium. The test was now made and showed that the velocity of light in water was only about three fourths that in air. This was strong evidence for the wave theory.

Foucault's experiment was by many regarded as a crucial test, and as a result the ether wave theory came into greater prominence and was, in fact, quite generally accepted.

In the meantime (about 1835) Faraday's researches, in a field apparently unrelated to light, had pointed to a need for a medium to explain electrostatic and magnetic effects. And a few years later (1863) in the process of developing a mathematical statement of Faraday's results Maxwell reached the conclusion that in such a medium as Faraday postulated it ought to be possible to establish electromagnetic waves. Furthermore, as soon as a numerical relationship could be established experimentally between electrostatic and magnetic units of measurement, the velocity of such waves was calculated and proved to be the same as that of light. This was an astounding discovery which excited the interest and admiration of the world.

Now it can easily be seen that if a luminiferous ether was necessary to account for the transmission of light, and an electromagnetic ether was needed in electrical theory, and if, furthermore, the velocity of

[3] F. Cajori, "A History of Physics," revised, p. 109.
[4] *Loc. cit.*, p. 110.
[5] "Classics of Science," *Science News Letter*, November 2, 1929, p. 273.

propagation of a disturbance proved to be the same in each the question would naturally arise whether the same medium might not answer both requirements. Maxwell concluded that light is an electromagnetic phenomenon and that light waves are in fact electromagnetic waves like those he had been studying, differing only in wave-length. This formulation of Maxwell's electromagnetic theory of light was regarded as one of the most brilliant generalizations in the history of science.

The production of long electromagnetic waves such as were first contemplated by Maxwell offered no appreciable difficulty, since suitable apparatus was available in almost any physics laboratory. But a detector or receiver for such waves by means of which their existence could be proved or demonstrated was a different matter. No one knew how to construct such a device, and as a consequence, verification of Maxwell's theory by experiment was for a time delayed.

Some years later (1888) Hertz succeeded in devising a receiver. As soon as he had done this he proceeded to a detailed study of the electromagnetic waves produced by his laboratory apparatus and verified the predictions of Maxwell's theory, showing that these waves were similar to light waves in many of their properties and were propagated with the same speed.

Supported by the results of Hertz's experiments, Maxwell's theory became firmly entrenched and the position of the ether concept, now greatly strengthened, seemed well-nigh impregnable.

Our discussion has now brought us near but not quite to the close of the nineteenth century. In those few remaining years discoveries were to be made which would have far-reaching effects on all branches of science. In 1895 Roentgen discovered the X-rays, and shortly thereafter came the announcement of radioactivity and the identification of the electron as one of the building-stones common to the atomic structures of all the elements.

These discoveries aroused the interest of the entire world and greatly stimulated scientific research in many fields. Their importance, so far as concerns our discussion, lies in the fact that they directed the attention of the scientific world to a closer study of the general subject of radiation.

The ether theory gave scant information as to the mechanism of the radiation process. It was a theory of transmission. It gave a good account of how the energy of light and radiant heat is carried through empty spaces and accounted for many of the phenomena characterizing transmission, but it did not explain the mechanism by means of which such energy is started on its way, and its explanation of the effects which accompany the absorption of this wave energy was hazy and at times wholly inadequate.

It now developed that certain phenomena of radiation and absorption could be explained on a satisfactory basis only on the assumption that radiation is a discontinuous process, that radiant energy is broken up into parts or parcels. And lo! there arose before the scientific world the specter of the corpuscular theory, the body of which had long since been laid away.

This time (1901) the theory was given the name of the quantum hypothesis, and it treated not of corpuscles but of quanta. It was a new theory, to be sure, but one which as it developed was to show a most striking resemblance to the corpuscular theory of a time more than two centuries past.

Now the X-rays were later found to be identical in character with light waves except as to wave-length. So also for the gamma rays, one of the radiations from radioactive bodies. These new forms of radiation fitted nicely into the ether wave series occupying regions in the wave scale hitherto vacant and unexplored. So also the new theory of atomic structures which gave a picture of the atom as consisting principally of wide open spaces really strengthened the ether theory by removing one of its great obstacles. It had been objected that the interpenetration of ether and matter was difficult to conceive, and so under the old theory of solid, closely packed atoms it was; but under the new theory of an open atomic structure this difficulty largely disappeared. These new discoveries, then, did but little if anything to impede the triumphant progress of the ether wave theory.

But the quantum theory, giving a more plausible explanation of radiation and absorption, constituted a real menace. I shall leave this consideration for the present, however, as we must now turn our attention to a different phase of the general question.

It was pointed out long ago that if this ether medium actually exists there ought to be an ether drift past the earth caused by the motion of the earth along its orbit. The effect here contemplated is analogous to the air drift one feels when traveling rapidly, in an open car for instance, through still air. Now if the earth moves through the ether without disturbing it there must be an ether drift, and light should be found to travel faster when moving with the ether than when it moves against, or across, the ether stream.

A little more than forty years ago (1887) an attempt was made by Michelson and Morley to detect or measure this effect. Elaborate preparations were made for this experiment and it was carried out with

the greatest possible care. The experiment gave negative results and this was generally accepted as proving the absence of an ether drift. "The earth seemed to drag the ether with it."

Now it must be allowed that the negative result of the Michelson-Morley experiment is to be interpreted in one of three ways. The first of these possible interpretations is that there is no ether. The second is that there is an ether but no drift because the ether is dragged along with the earth. The third interpretation is that there is an ether and also an ether drift, but for some reason the drift was not detected in the experiment.

It is significant as showing the firm hold which the ether theory had on the minds of men that few, if any, accepted the results of this experiment as proving the non-existence of the ether and practically all explanations offered were based upon the second or third interpretation.

Sir Oliver Lodge attempted to demonstrate an ether drag between two massive steel plates revolving at enormous speeds, but was unsuccessful. Had this experiment succeeded, an explanation might have been possible under the second interpretation.

FitzGerald and others directed attention to the third interpretation and suggested inherent defects in the method, the apparatus or perhaps in both. A suggestion offered by FitzGerald was of far-reaching importance. He pointed out that if, as modern theory would indicate, matter is electrical in its nature, it may contract in the direction of motion as it moves through the electromagnetic ether. Such contraction, he explained, would under ordinary circumstances quite escape attention since any scale used to measure it would also be subject to the same effect, so that, in the direction of motion, the unit of length would be shortened.

Thus the various parts of the Michelson-Morley apparatus, although not showing it in any other way, might change in length, as they were placed alternately parallel and perpendicular to the direction of motion, to such an extent as to compensate for the effect it was expected the test might show. This suggested explanation, known as the FitzGerald contraction, was at first not altogether well received, no doubt largely because of its very novelty.

The justly famous Michelson-Morley experiment, it would seem, has thus far yielded results of doubtful significance. It has been repeated a number of times by Morley and Miller and by Miller and others in different localities, at different altitudes, with more elaborate equipment and under better conditions as to temperature control, always with results more or less open to question. However, it should here be recorded that Miller, in his report to the National Academy of Science last year, stated that he believes he has measured an ether drift, although he is not yet ready to pronounce it an established fact.

Just after the opening of the present century (1905) the scientific world was set to thinking about these and related matters in a new way. This was occasioned by the announcement of Einstein's special theory of relativity. This theory teaches that when such changes as the FitzGerald contraction take place in our standards we must, in the very nature of things, be totally unaware of them, since we move with them and suffer like changes ourselves, but they might be measurable to an observer having different motion. It follows logically that time and space are therefore not absolute concepts but are relative only, in any given case, to the observer.

Under this theory the negative results of the Michelson-Morley experiment are exactly what one would expect. Indeed, one of the two great postulates upon which this theory is founded states that the velocity of light is always the same whatever the apparatus used in its determination, whatever the circumstances under which the measurement is made.

It is sometimes asserted that Einstein's theory is founded upon the negative results of the Michelson-Morley experiment and that it denies the existence of the ether. These statements are only partially true and perhaps should not be regarded as serious objections to the relativity theory. It seems probable that if, perchance, the ether drift is at last demonstrated to be a fact, this or an equivalent theory will be reconstructed on a similar, or possibly quite different, basis, for the results which have come from the theory of relativity seem of themselves a sufficient justification of the theory.

As regards the other assertion, it may be pointed out that Einstein concedes that the ether concept can not at present be dispensed with even in this strange world which he has builded on the foundation of relativity.

Our attention turns now to a consideration of some of the more recent developments in the new physics. The quarter of a century which has elapsed since the advent of Einstein's special theory will long be celebrated in the story of scientific progress for the revolutionary changes which it has witnessed in the theories and methods of physical science. It is probably not too much to say that never in the history of man's intellectual advance has there been a similar period so filled with changing theory! These new theories have to do largely with the structure of matter and the nature of radiation, and to them all the subject of the ether concept is related in an important way.

It might easily be imagined that as the quantum

theory advanced step by step, becoming apparently ever more firmly established, the ether wave theory must have become of lesser and lesser importance. But evidently such has not proved to be the case.

The quantum theory grew in power as it helped to solve the problems of emission and absorption, but it was unsatisfactory in explaining the phenomena of transmission. On the other hand, the wave theory gave a good account of transmission, and as a consequence being firmly entrenched in this field, was able in a large measure to withstand the onslaughts of the quantum hypothesis.

It will not be out of place to mention here one or two points of advantage possessed by the wave theory. The quantum theory does not give a satisfactory answer to the question: Why do all quanta, large and small, travel through empty space with the same velocity? It is understood that quanta vary greatly in size. The constant of this theory is a factor, h, which multiplied by the associated frequency in a given case gives the quantum energy. Hence the quantum of high frequency radiation is relatively large, while that of low frequency radiation is small.

It does seem strange that two radiators, the one hot and the other cold, throwing off, therefore, quanta of different size, should shoot them out into space with exactly equal velocities. Now there is nothing strange about equal velocities of waves in the ether. Ether wave velocities depend upon the ratio of what we may call the elasticity and mass properties, actually the electric and magnetic properties, of the ether, and upon these alone. Such velocities are therefore always the same regardless of wave-length. We have a somewhat analogous case in the passage of sound waves through the air. Under ordinary conditions, at least, long and short sound waves travel with the same speed.

In other cases the advantages of the wave theory are not so apparent. For example, the quantum theory gives no answer to the question: How large is a quantum? The wave theory, of course, is not called upon to answer this specific question, but is required to answer a closely related one which is almost equally difficult, as we shall see.

An examination of the star image formed by a one-hundred-inch reflecting telescope indicates that the quantum must reach all parts of the mirror. This means that a quantum must be large enough to cover a mirror more than eight feet in diameter. But if light from this same star falls directly upon a potassium film it will eject electrons. This means a quantum must be small enough to enter an atom. It is very difficult to reconcile these results.

Now if we try to explain such effects from the standpoint of the wave theory we also get into trouble. There is, of course, no difficulty in covering a one-hundred-inch mirror with an ether wave front but when we come to the effect upon the potassium film the matter is not so simple. Each electron thrown off from the film escapes with a definite speed and carries away a definite energy, the amount of which has been shown to depend upon the incident light alone. It varies with the wave-length of the incident light but is independent of its intensity. It is the same for feeble light as for strong.

This curious but apparently well-established fact that light of low intensity ejects electrons from the potassium film with the same velocity as that produced by light of the same quality but much higher intensity is called the "photoelectric paradox." The electrons ejected under high intensity radiation are more numerous but they travel with no greater speed.

To illustrate, when light from the star Sirius, fifty billion miles away, falls upon the potassium film, the electrons are actually ejected with greater speed or energy than they are when stimulated by exposure to the light from the sun. This effect does seem altogether paradoxical, since the sun's light is enormously more intense and, as already stated, the energy of the ejected electrons comes from the stimulating radiation. But the energy of the electron emitted does not depend upon the intensity of this radiation. It is determined by the frequency alone. Now Sirius is a bluer, that is, a hotter, star than the sun. Thus it comes about that notwithstanding its low intensity the light from the star, because of its higher frequency, can throw out electrons from potassium at the higher speed.

But how are these effects to be explained on the basis of the wave theory? Consider the spread, the extreme attenuation of the energy of this spherical wave front having a radius of fifty billion miles. How can it carry still, in a microscopic portion of its wave front, the energy requisite to this atomic explosion?

There are then certain phenomena well accounted for by the quantum hypothesis, others which are more readily explained by the wave theory and certain others which are not very well described by either.

This state of affairs has enabled the wave theory, in spite of its shortcomings, largely to hold its own in the face of the rising popularity of the quantum hypothesis. And so it has come about that with the passing years both these rival theories have continued in use.

In his fascinating book, "The Nature of the Physical World," published about a year ago, Eddington reminds us that "for at least fifteen years we have used classical laws and quantum laws alongside one another notwithstanding the irreconcilability of their

conceptions."[6] And farther on by way of illustration he says:

> In my observatory there is a telescope which condenses the light of a star on a film of sodium in a photoelectric cell. I rely on the classical theory to conduct the light through the lens and focus it in the cell; then I switch on to the quantum theory to make the light fetch out electrons from the sodium film to be collected in an electrometer. If I happen to transpose the two theories, the quantum theory convinces me that the light will never get concentrated in the cell and the classical theory shows that it is powerless to extract the electrons if it does get in. I have no logical reason for not using the theories this way round; only experience teaches me that I must not.

He goes on to quote the famous saying of Sir William Bragg that "we use the classical theory on Mondays, Wednesdays and Fridays, and the quantum theory on Tuesdays, Thursdays and Saturdays," and then remarks, "Perhaps that ought to make us feel a little sympathetic towards the man whose philosophy of the universe takes one form on week-days and another form on Sunday."

It is the conviction of many, if not all, physicists that a rearrangement of our ideas of the physical world will come which will reconcile these two great theories. Some apparently believe it will come through a further development of the classical theory; others that it will come from the other side.

We turn now to a consideration of the ether concept in relation to the modern theories of atomic structure.

The atom, according to Bohr's theory, consists of a central nucleus of large mass and positive charge about which minute negative electrons revolve like satellites in a miniature solar system. These electrons are restricted to certain special orbits and the atom can neither radiate nor absorb energy while the electrons continue their orbital motions unchanged. According to Bohr, radiation or absorption is possible only when electrons jump from one orbit or "energy level" to another. The assumptions upon which this theoretical structure is based are founded upon a strange mixture of the classical theory, the quantum hypothesis and the general theory of relativity.

This picture of the atom was for a time remarkably successful, particularly in explaining such facts as the curious grouping of lines in the spectra of the elements. However, there are certain other matters, such as line intensities and particular line groupings, which it explained in a way not altogether satisfactory, if at all. It was recognized some time ago that this theory would have to be modified if not altogether replaced by a new theory of atomic structure.

[6] A. S. Eddington, "The Nature of the Physical World," p. 194.

A number of physicists have been active in this field of investigation. Outstanding among these are de Broglie, Heisenberg, Dirac and Schroedinger. In the past few years the theories proposed by these men have been repeatedly revised and extended until at the present time we have an entirely new picture of the atom.

Under the new theory of "wave mechanics" which has resulted, the electrons within the atom are believed to be accompanied by groups of waves, the extreme assumption being that an electron consists entirely of waves, that the wave group is, in fact, the electron. This is a theory which is apparently quite as good as Bohr's theory in its own field and appears to be capable of much greater extension.

A few years ago A. H. Compton discovered experimentally an effect which seemed to indicate that waves sometimes behave like particles, and Davisson and Germer proved that electrons reflected from a crystal of nickel are grouped in a manner to indicate that small particles in rapid motion behave somewhat like waves.

Also G. P. Thomson by passing a stream of cathode rays or swiftly moving electrons through a very thin metal film found that the metal scattered the electrons, the distribution of the scattered electrons being exactly that which would occur in the diffraction of waves like X-rays by the known crystal structure of the metal film.

Now it had been suggested by de Broglie that the reason the electron in the atom behaves in such a peculiar manner, seemingly following at one time the classical laws and at another the rules of the quantum theory, was that its real nature was more like that of a wave than a particle. It is easy to understand that the results of the experiments just described are in accord with de Broglie's hypothesis.

We must now consider how the phenomena just recounted are related to the ether hypothesis and determine what rôle the ether plays in the new wave mechanics.

You will understand that waves and wave groups are conspicuous features of this new theory. But waves in what?

It must strike the student of wave mechanics rather forcibly that while the discussion of these waves and their properties is quite free from hesitation and embarrassment any mention of the wave medium is made apparently with great reluctance and where possible is avoided altogether. Now a wave is a disturbance of the equilibrium of a medium. Without a medium there can be no waves, and to postulate waves is to postulate a medium in which such waves are formed and propagated.

The real explanation of this strange situation is

found not in any disinclination on the part of the modern physicist to make use of the ether concept, which has been so freely employed in earlier science, but rather in the failure on the part of the ether to qualify in this particular field. For the medium required by the wave mechanics is a dispersive medium, that is, one in which waves of different length have different velocities. It is a necessary requirement that the shorter waves shall travel faster than the longer ones. Now in the ether all waves travel with the same speed. The ether, therefore, is unable to meet the requirements of this new theory.

For the first time, says G. P. Thomson, physics is faced with waves in empty space which do not fit into the ordinary series of ether vibrations.[7] These electron waves are of about the size of those in the X-ray spectrum, but of course they can not be X-ray waves, since these belong to the ether series and have the properties of ether waves.

To meet this difficulty the bold suggestion is made that we postulate an entirely new medium having the desired characteristics. Enters now the concept of the *subether*. Concerning this assumption Thomson says, "It is not a very attractive idea to have two ethers filling space, especially as the waves of protons, if they exist, would demand yet a third. Space is getting overcrowded."[8]

It is significant that the subether is proposed as an additional medium and not as a substitute for the ether of earlier theory. This can be interpreted only as meaning that regardless of the need for a dispersive medium we can not dispense with the luminiferous ether; that this medium is still necessary in our thinking to account for the propagation of all those forms of radiation heretofore classified as ether waves.

The universe is made up largely of open spaces. The stars and the island universes we see in the night sky are at almost inconceivable distances from the earth, and they are separated from each other by spaces equally great. Ordinary matter is constructed on the same plan. It is extremely porous. This is a fact which ordinarily escapes our attention; but if it were possible sufficiently to magnify its structure, modern theory teaches that so magnified its appearance would be much like that of the sky at night. We should see a multitude of material specks separated by great distances like those between the stars.

Across these spaces these specks of matter, stars and atoms, act upon each other. They are bound together by gravitation, by electrostatic and magnetic forces and by cohesion, and between them various forms of energy are incessantly streaming to and fro. Do these forces and energy streams extend through empty space? Or is there a medium for their transmission?

It may be difficult to conceive of a non-material, all-pervading medium which serves as a carrier of these forces; but it is even more difficult to imagine these interactions in a space which is absolutely void.

Newton said:

> That one body may act upon another at a distance, through a vacuum, without the mediation of anything else by and through which their action may be conveyed from one to another, is to me so great an absurdity that I believe no man, who has in philosophical matters a competent faculty for thinking, can ever fall into it.[9]

Sir Oliver Lodge says:

> Always look for the medium of communication: it may be an invisible thread, as in a conjuring trick; it may be the atmosphere, as when you whistle for a dog; it may be the ether, as when you beckon to a friend.[10]

Says Einstein:

> To deny the ether is ultimately to assume that empty space has no physical properties whatever. The fundamental facts of mechanics do not harmonize with this view . . . According to the general theory of relativity space without ether is unthinkable, for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time.[11]

And finally, as regards the importance of the ether concept in modern physics we shall probably be inclined to agree with Eddington who expresses his views in the following words.

> We need an ether. The physical world is not to be analyzed into isolated particles of matter or electricity with featureless interspace. We have to attribute as much character to the interspace as to the particles, and in present-day physics quite an army of symbols is required to describe what is going on in the interspace. We postulate ether to bear the characters of the interspace as we postulate matter or electricity to bear the characters of the particles. . . . The ether itself is as much to the fore as ever it was, in our present scheme of the world.[12]

[7] SCIENCE, December 6, 1929, p. 545.
[8] *Ibid.*

[9] Quoted by Lodge, "Ether and Relativity," p. 79.
[10] *Loc. cit.*, p. 80.
[11] "Sidelights on Relativity," quoted by Lodge in "Ether and Reality," p. 123.
[12] A. S. Eddington, "Nature of the Physical World," pp. 31–32.

OBITUARY

HARVEY WASHINGTON WILEY

DR. WILEY was born in Kent, Jefferson County, Indiana, on October 18, 1844. His broad education was achieved in spite of the almost complete absence of early opportunities. Public schools were unknown there in his early life. In his rural community schools were supported by subscription, when available at all, and were limited to about three months during the winter season.

Until 1862, when he was eighteen years of age, his schooling consisted of four of these winter sessions. During that year he entered the preparatory department of Hanover College. During his sophomore year in college, in May, 1864, he enlisted in the Union Army and served until the end of the war. He graduated from Hanover in 1867, having given his chief attention to Latin and Greek, although it was his aim to study medicine.

In 1868, he was appointed instructor of Latin and Greek in the Northwestern Christian University, now Butler University, at Indianapolis. While occupying that position he studied at the Indiana Medical College and received the degree of doctor of medicine in 1871. The following year he was appointed professor of chemistry of the Indiana Medical College and given a year's leave of absence at his request for advanced study. This year was spent at Harvard College, where he was given the degree of bachelor of science in 1873.

In 1874, Purdue University was organized and Dr. Wiley was appointed professor of chemistry, which position he held until appointed chief chemist of the U. S. Department of Agriculture in the spring of 1883. During this period he spent a year in Europe where he had the opportunity to work with Dr. Sell, the director of the Imperial Health Laboratory at Berlin. Here he became familiar with the work of that laboratory on food analysis and particularly on the examination of sugars and syrups. On returning to Purdue he secured a small appropriation from the state legislature, which made possible a systematic examination of the sugars and syrups then on sale in Indiana. He also had some practical experience at that time in the manufacture of sorghum syrup and sugar.

The most noteworthy achievement of the first ten years of Dr. Wiley's service as chief chemist of the Department of Agriculture was probably the series of contributions made by him and his associates to the manufacture of sugar. Largely owing to his efforts, strains of beets were developed with a higher sugar content than was formerly known. Exhaustion batteries used in the manufacture of beet sugar were introduced into the cane sugar industry and led directly to the improvement of the presses of that industry to a much higher degree of efficiency. During this same period epoch-making contributions were made under Dr. Wiley's direction to the chemistry of soils and of cereals.

During the same period much attention was also given to the subject of food analysis, especially for the purpose of detecting adulterations. As a result of this work, Bulletin 13 was published, consisting of ten parts. The first part, on dairy products, was published in 1887, and the tenth part, on preserved meats, in 1902. This series of bulletins, giving the methods of analysis developed for the various products studied and the results obtained by those methods from foods purchased in the markets, afforded the best literature of that time on the subjects of food analysis and food adulteration.

During his first year as chief chemist of the Department of Agriculture, Dr. Wiley was elected president of the Association of Official Agricultural Chemists at its third annual meeting and was more active than any other member of the association while he remained in official life. At the sixth annual meeting of the Association of Official Agricultural Chemists, he was elected secretary, which position he held until he resigned from the department in 1912. He was then made honorary president of the association and addressed each meeting until the year 1929, when illness prevented him from attending the meeting.

His studies on food adulteration impressed on him the need of federal legislation which would control the purity of foods and drugs. He wrote many articles and gave many addresses on this subject. The first pure food bill was introduced in Congress in 1889. Various bills were introduced after that time, but manufacturing interests succeeded in preventing their passage for a period of seventeen years. Finally in 1906, the Food and Drugs Act, written by Dr. Wiley, was passed by Congress and signed by the President. Its passage and perhaps its approval by the President were the results of a tremendous popular demand which was due undoubtedly to the personal influence of Dr. Wiley.

His life was militant and, perhaps, spectacular. He had many enemies as a result of his intense activity in behalf of legislation for the public good. Largely because of the same activity, his friends were beyond number. Intensely partisan, he retained the respect and admiration of the most bitter opponents of his policies. Although the center of a series of storms during his long and active life, his buoyant

wit and humor averted many a threatened clash and won many victories.

He had the faculty of applying his fertile mind intensely and worked rapidly. When a period of work was over he was able to dismiss it entirely from his mind. He was an ardent baseball fan and, in fact, was interested in sports of all kinds. His kindly interest in their welfare endeared him to his associates. A keen student of human nature, he was a prince of good fellows. He loved a good story, and always told a better one. He was a patron of literary and musical events of his community.

He owned the third automobile in Washington and always claimed to have met with the first accident, in which he encountered the first "hit-and-run" driver, who, however, drove a team of horses and not an automobile. His experience at Purdue University led him into several embarrassing situations because of his tendency to vary from accepted traditions. During that period, for instance, charges were preferred against him for donning a uniform and playing baseball with the boys and also for riding a bicycle while wearing knee breeches.

His activities were not, by any means, limited to his duties as chief chemist of the Department of Agriculture. Before and after his resignation from that department he published a series of books, which alone were sufficient for a man's life work. He was elected president of the American Chemical Society in 1893 when it numbered some four hundred members. He remained president for two years, when largely because of his activities the membership of the society had increased to over a thousand. During this period he presided at the World's Chemical Congress which met at the Chicago Exposition in 1893.

After his resignation from the Department of Agriculture in 1912, he wrote a chapter for each issue of *Good Housekeeping* and conducted a correspondence bureau for that magazine until January 1 of the present year. During the first seven years after his resignation from the department he also lectured in Chautauqua circles. Then, because of failing eyesight and defective hearing, he gave up regular lecturing.

In 1921 the cataracts which were forming in his eyes reached the stage which required operation. For a time he was unable to read; always after that he read with difficulty. His hearing had become impaired. These limitations lessened his diversions but increased the constancy and earnestness of his work. He continued to publish books, to write his regular chapter for *Good Housekeeping* and to conduct an extensive correspondence bureau. He continued to participate in public hearings relating to a wide range of popular interests. Within a month before his death he participated in two public hearings relating to the enforcement of the Food and Drugs Act.

To the public Dr. Wiley was best known as the "father of the pure food law." Those who knew more intimately the position he achieved in the field of science, both at home and abroad, the breadth of his vision, the courage of his character and the scope of his interest in all questions relating to the public welfare recognized in him a leader among leaders—a man whose death on the thirtieth of June was an international loss.

W. D. Bigelow

SCIENTIFIC EVENTS

THE SIXTEENTH INTERNATIONAL GEOLOGICAL CONGRESS

Representatives of the principal geological groups in the United States have selected a committee on organization for the next meeting of the International Geological Congress which will be held in the United States in 1932. The officers of the committee so far chosen are: Honorary president, Herbert Hoover, President of the United States; chairman of the committee, Professor Waldemar Lindgren, Massachusetts Institute of Technology; general treasurer, Professor Edward B. Mathews, the Johns Hopkins University; general secretary, W. C. Mendenhall, U. S. Geological Survey; assistant secretaries, H. G. Ferguson and M. I. Goldman, U. S. Geological Survey. The members of the committee are as follows.

L. K. Armstrong, Spokane, Washington; Dr. H. Foster Bain, American Institute of Mining and Metallurgical Engineers; Professor A. M. Bateman, Yale University; Dr. C. P. Berkey, Columbia University; Dr. Eliot Blackwelder, Stanford University; Dr. Isaiah Bowman, American Geographical Society; H. A. Buehler, State Geological Survey, Missouri; Professor R. A. Daly, Harvard University; Dr. A. L. Day, Geophysical Laboratory, Carnegie Institution; E. DeGolyer, New York City; C. A. Fisher, Denver, Colorado; H. G. Ferguson, U. S. Geological Survey; M. I. Goldman, U. S. Geological Survey; President W. O. Hotchkiss, Michigan College of Mining and Technology; Arthur Keith, National Research Council; Dr. H. B. Kummel, State Geological Survey, New Jersey; Professor H. Landes, University of Washington; Professor A. C. Lawson, University of California; Dr. C. K. Leith, University of Wisconsin; Professor Waldemar Lindgren, Massachusetts Institute of Technology; Professor E. B. Mathews, the Johns Hopkins University; W. C. Mendenhall, U. S. Geological Survey; Professor R. A. F. Penrose, Jr., Philadelphia; Dr. Sidney Powers, Amerada Petroleum Corporation, Oklahoma; W. E. Pratt, Humble Oil and Refining Com-

pany; Dr. George Otis Smith, U. S. Geological Survey; Scott Turner, U. S. Bureau of Mines; W. E. Wrather, Dallas, Texas; David White, U. S. Geological Survey.

The committee on organization has appointed the following officers and members as an executive committee: Professor Waldemar Lindgren, Professor Edward B. Mathews, W. C. Mendenhall, Dr. H. Foster Bain, Dr. C. P. Berkey, E. DeGolyer and David White.

The general sessions of the congress will be held early in June, 1932, in Washington, D. C., the precise date to be announced later. They will be preceded late in May, and followed in June and early in July, by a series of excursions.

The conditions of membership in the congress are here outlined: "No professional title is required to register. Nevertheless, the excursions organized before and after the sessions will be more especially reserved for the members of the congress who are geologists, geographers and mining engineers and for other persons who devote themselves to the study or practice of some branch of geology."

Following the admirable practice of recent congresses, each of which has prepared a special volume on the world reserves of some mineral resource that is particularly well represented in the country in which the congress is held, the organization committee of the sixteenth congress is planning the preparation and publication of a monograph on the petroleum resources of the world. It is expected that selected papers on the geology of petroleum will have conspicuous places on the program of the sessions. The following topics of current interest to geologists are also proposed for consideration by those who plan to attend the congress:

1. Estimates of geologic time by method.
2. Batholiths and related intrusives.
3. Origin of lead and zinc deposits like those of the Mississippi Valley and Silesia.
4. Zonal relations of metalliferous deposits.
5. Evidence of cycles in sedimentations, including valves.
6. Major divisions of the Paleozoic system.
7. Boundaries of the Tertiary system and its major divisions.
8. Adaptation of extinct animals and plants to their environment as indicated by fossils.
9. Physiographic processes in arid regions and their resulting forms and products.
10. Fossil man.

Offers of papers or comments on these topics or suggestions as to other desirable topics are invited and should be submitted to the general secretary as soon as possible.

Excursions are planned for members of the congress to various points of interest in the United States. Inquiries or proposals relating to the work of the sessions or to the future activities of the committee should be addressed to the organization committee through the general secretary, Sixteenth International Geological Congress, Washington, D. C. Circulars to be issued later will present additional details and will record progress in the development of plans for the congress.

HARVARD FOREST FUND

THE oldest forest experiment station in the country, the Harvard Forest at Petersham, Massachusetts, will now be able to carry on its forestry study with greater facility, according to an announcement made recently by the director, Professor Richard T. Fisher, instructor in the Bussey Institution of Harvard University, who said that the endowment of $200,000 for research work has now been completed.

Charles Lathrop Pack, of Lakewood, N. J., noted financier and one of the fathers of the forest conservation movement, started the endowment, which is known as the Charles Lathrop Pack Forestry Trust, with a gift of $100,000. It was stipulated in the donation that a similar amount should be obtained from other donors.

Of two gifts by Mr. Pack during the past two years, one was to Yale University, a tract of forest land located near Keene, N. H., adjacent to the forest land already owned by Yale University; the other, a gift of $200,000 to the University of Michigan to establish a foundation for the promotion of practical forestry management.

Mr. Pack is president of the American Tree Association of Washington, D. C. More than any other individual, he has succeeded in putting the importance of reforestation before the public in a way which has made it known to thousands. Through his efforts millions of American tree seeds have been sent to Europe to help in reforesting devastated areas.

The Harvard Forest, which is connected with the Bussey Institution, offers boundless facilities for the studies of forest entomology, forest management and silviculture. Among other accomplishments it has shown how new timber can be grown profitably on land which has once been cut over.

Harvard University first acquired land in Petersham in 1907 when a gift of about 2,000 acres of valuable timberland, about five miles from Athol on the Athol-Petersham road, was made possible through the generosity of John S. Ames, of Boston. Several neighboring tracts were later added.

WOMAN'S COLLEGE AT DUKE UNIVERSITY

WE learn from the Baltimore *Sun* of the opening of the Woman's College of Duke University, one of the new divisions of the institution, on September 24.

With the freshman class of the college restricted to 250 students, women students will have a well-equipped plant of their own for the first time.

Included in the buildings on the Woman's College campus is the group of eleven buildings completed in 1927 at a cost of approximately $4,000,000 and erected especially for the uses of women. Since that time, however, these buildings have been occupied by men pending the completion of the university's larger plant on an adjoining campus.

While students of the Woman's College will have full physical equipment and academic facilities of their own, they will be permitted to take courses on the main university campus if they desire to do so. Included also in the new Woman's College plant is the large gymnasium built several years ago as a memorial to Trinity College alumni who died during the World War. This unit will permit a full program of intramural sports among the women students. There are nineteen buildings in the Woman's College group, situated on a 110-acre campus.

In addition to members of the university faculty who will teach in the Woman's College, additional teachers have been added to the staff to give the Woman's College ample instructional services. Dr. Alice M. Baldwin, who has been dean of women at Duke University for several years, is dean of the Woman's College.

Degrees were conferred upon women by Trinity College as early as 1878, but the real history of education of women at the college did not begin until 1896.

MINING AND METALLURGICAL ADVISORY BOARDS

THE fourth annual meeting of the Metallurgical Advisory Board to the U. S. Bureau of Mines and the Carnegie Institute of Technology, which will take place on October 17, at Pittsburgh, Pa., will open in the auditorium of the Bureau of Mines with an address of welcome by Dr. F. N. Speller, chairman of the advisory board and director of the department of metallurgy and research of the National Tube Company. Following this, metallurgists of the bureau of metallurgical research, Carnegie Institute of Technology, will give a progress report on iron-manganese-carbon alloys, a study which has been conducted by them for several years. Dr. F. M. Walters, Jr., director of the bureau, Dr. V. N. Krivobok, Dr. J. B. Friauf, Mr. Cyril Wells and Mr. Maxwell Gensamer, associates, will present papers on different phases of this study. Dr. Krivobok will also report on his studies on the stainless iron alloy.

During the afternoon session Dr. C. H. Herty, Jr., physical chemist of the U. S. Bureau of Mines, and Dr. G. R. Fitterer, associate metallurgist, will present an illustrated report on slag viscosity and deoxidation with aluminum-silicon alloys, and a progress report on fundamental studies in the laboratory. Dr. Herty will also deliver a report on plant research in open-hearth steel. The several reports will be interspersed with discussions by prominent metallurgists from all parts of the country relative to steel problems.

The meeting which will be held in the evening at the Pittsburgh Athletic Club will be followed by an informal dinner at which Dr. Thomas S. Baker, president of the Carnegie Institute of Technology, will preside.

THE INTERNATIONAL INSTITUTE OF AGRICULTURE

THE New York *Times* reports that the international Institute of Agriculture, founded in Rome by a distinguished Californian, David Lubin, is about to celebrate its twenty-fifth anniversary. From its humble origins twenty-five years ago when its foundation was possible only through the munificence of the King of Italy, it has now become one of the most important of international organizations and counts seventy-four states among its members. It has fulfilled the dream of its founder, becoming a kind of agricultural League of Nations, but David Lubin is no longer alive to see the triumph of the child of his genius.

For the celebration of the twenty-fifth anniversary the greatest meeting of ministers of agriculture that ever occurred will be held in Rome. Ministers of agriculture of all seventy-four member states have been invited and it is believed almost all will attend. The King of Italy will be present as patron of the institute and the meeting will address to him expressions of gratitude for the rôle he played twenty-five years ago.

It is expected also that advantage will be taken of the presence of such a large number of ministers of agriculture to discuss numerous subjects affecting the future of the institute and increasing its usefulness to humanity.

The real celebration of the anniversary, however, will take the form of bringing to completion the work of a complete census of agricultural activities of the whole world which was begun five years ago.

Two hundred governments—almost all the governments in the world—contribute to this census. Questionnaires were submitted to the governments by the institute, which also assumed the task of classification of the replies. This is said to be an improvement on the system followed hitherto, because the various governments which have been publishing information about their agriculture have done so in such different manners that comparison between one nation and another was extremely difficult.

Of the two hundred governments, only about sixty

hitherto have taken censuses of agriculture and very few of these refer to the same year. Annual statistics of principal agricultural products published by most of them are simple approximations of estimates which can be relied on only slightly.

The institute in 1925 established an office in Rome headed by specialists. Its first task was to formulate a program for the world census and then to prepare the questionnaires in all languages of the world, with clear indications for answering them to insure uniformity. Final figures on the census have begun reaching Rome. It is hoped that before the end of the year the material will be complete, permitting publication of the census.

SCIENTIFIC NOTES AND NEWS

PROFESSOR ALBERT PERRY BRIGHAM, professor of geology at Colgate University since 1892 and consultant of geography at the Library of Congress in Washington, will represent the American Geographical Society at the one-hundredth anniversary of the Royal Geographical Society in London in October.

DR. JOHN FARQUHAR FULTON, JR., of Oxford University, has been appointed Sterling professor of physiology at Yale University. Dr. J. G. Dusser de Barenne, formerly professor of physiology at the University of Utrecht and neurologist at St. Antonious Hospital, has been appointed professor of physiology.

DR. JOHN M. THOMAS, president of Rutgers University since 1925, will resign soon to become a vice-president of the National Life Insurance Company of Montpelier, Vt.

MR. JULIUS ROSENWALD, founder of the Museum of Science and Industry, at Chicago, is the recipient of the golden ring of the museum presented by the government of the Free State of Bavaria. Consul General H. F. Simon presented the ring to Mr. Rosenwald on behalf of the Bavarian Ministry of Education and Culture.

THE British Institution of Civil Engineers has awarded Telford Gold Medals to Messrs. David Anderson and B. B. Haskew and a Watt Gold Medal to Mr. A. E. L. Chorlton.

THE Alvarenga Prize of the College of Physicians of Philadelphia has been awarded to Dr. H. A. Harris, assistant professor of anatomy at the University College, London, for an essay entitled "Cod-liver Oil and the Vitamins in Relation to Bone Growth and Rickets."

THE following appointments have recently been announced by Princeton University: Dr. Eugene Pacsu, formerly a member of the faculty of the University of Budapest, has become assistant professor of chemistry; Dr. Edward U. Condon, formerly professor of theoretical physics at the University of Minnesota, has become associate professor of physics; Lewis F. Moody, prominent industrial engineer and a former member of the faculty of the University of Pennsylvania and of Rensselaer Polytechnic Institute, has become professor of hydraulic engineering; Clyde Whipple, of the Brooklyn Polytechnic Institute, is visiting associate professor of engineering.

DR. ROBERT KEITH CANNAN, of the University of London, has been appointed professor of chemistry at the medical college, New York University.

DR. HARRY G. PARKER, formerly of William Jewell College, has been appointed professor and head of the department of chemistry at Park College.

THE president of Union College announces the following additions to the faculty: Vladimir Rojansky, associate professor of physics; Russell A. Hall, assistant professor of civil engineering, and Egbert K. Bacon, instructor in chemistry.

AMONG the more important appointments at the University of New Hampshire are: Dr. James A. Funkhouser, assistant professor of chemistry, recently instructor in organic chemistry at Ohio State University, and Charles O. Dawson, recently employed on topographic survey work for airports in St. Louis and in Pennsylvania, instructor in civil engineering.

PROFESSOR DUGALD C. JACKSON, JR., formerly head of the department of mechanical and electrical engineering in the Speed Scientific School of the University of Louisville, has been appointed head of the department of electrical engineering in the University of Kansas.

THE following additions will be made to the faculty of the department of psychology at the University of Kentucky: Dr. Martin M. White, assistant professor; Dr. Henry Beaumont, executive secretary of student personnel service; Dr. Graham B. Dimmick, in charge of advanced courses, and Mr. Edward Newbury, instructor. They replace Dr. Paul L. Boynton, Dr. Gardner C. Bassett and Dr. James L. Graham, who have accepted positions at the George Peabody College for Teachers, Gettysburg College and Lehigh University, respectively.

DR. OSCAR EDWARD HERTZBERG, formerly professor of educational psychology in the Colorado State

Teachers College at Greeley, has accepted a position as head of the new department of educational psychology at the New York State Teachers College at Buffalo.

LEIF VERNER, formerly assistant professor of horticulture at the University of Idaho, has been appointed assistant professor of horticulture, assistant horticulturist and extension horticulturist at the West Virginia Agricultural Experiment Station. G. Gordon Pohlman, formerly assistant in agricultural chemistry at the University of Idaho, has been appointed assistant professor of agronomy and assistant agronomist. French M. Hyre, assistant county agent of Greenbrier County, has been appointed an assistant in farm economics. He will conduct the field work in the study of farm cooperatives of West Virginia in cooperation with the Federal Farm Board.

THE following appointments have been made at the University of Wisconsin: Edward M. Searles, assistant professor in economic entomology; Edward W. Azpell, instructor in steam and gas engineering; William R. Birnbaum, assistant in anatomy, and Louis Pruess, research assistant in agricultural bacteriology.

WE have been notified by George I. Cochran, president of the board of trustees of the University of Southern California, of the following additions to the faculty of the university. Appointments in the school of medicine are as follows: Dr. Daniel B. MacCallum, assistant professor of anatomy; Dr. Howard F. West, clinical professor of medicine; Dr. John C. Ruddock, Dr. Bertrand Smith, Dr. Arthur S. Granger and Dr. Roy E. Thomas, assistant clinical professors of medicine. Additions to the College of Letters, Arts and Sciences, are: Dr. Donald H. Loughbridge, physics; E. L. Bikerbike, J. E. Lawrence and Antonio Gandara, chemistry; Dorothy Fox, zoology; Dr. W. B. McDougall, botany; Thelma Littrell, mathematics; and the following in the department of physics-optics: Dr. Elmer R. Jones, supervisor of refraction laboratory; W. B. Clark, Dr. J. C. Goodsell, Dr. Arthur E. Hoare, Carrie B. Hooker, Dr. Ernest A. Hutchinson, Percy C. Kinney, Dr. Harry J. Hoare, and Leslie W. Scown, lecturers. In the College of Engineering Nathan C. Clark has been appointed instructor in electrical engineering; A. E. Stevens, instructor in general engineering, and James M. Shoemaker, lecturer in aeronautical engineering.

DR. CHARLES SCOTT BERRY, professor of educational psychology at the University of Michigan and consultant in special education for the Detroit public schools, has been appointed to the staff of the state department of education of Ohio in the newly created office of consultant in the education of the mentally handicapped.

THE appointment of Francis X. Schumacher as chief of the section of forest measurements in the Forest Service, U. S. Department of Agriculture, has been announced by R. Y. Stuart, chief forester. Mr. Schumacher, who has been teaching forestry in the University of California, will assume his new duties in Washington on October 1. He will succeed V. A. Clements, who will take up duties at the California Forest Experiment Station.

DR. MAX M. ELLIS, professor of physiology in the school of medicine of the University of Missouri, has been appointed to a responsible directive post as an investigator in the U. S. Bureau of Fisheries. While the fish cultural investigations now conducted at Fairport will still remain under the direction of Dr. H. S. Davis, the biological activities of the station will be supervised by Dr. Ellis.

DR. AUSTIN M. CRAVATH, Dr. John H. Findlay and Dr. Charles A. Swartz have been added to the staff of the research department of the Union Switch and Signal Company at Swissvale, Pa.

PROFESSOR DR. KEIJIRO ASO, of the Tokyo Imperial University, a well-known agricultural chemist who was one of the early students of Professor Oscar Loew and who was an official delegate to the International Congress of Soil Science which was held in Russia last July, will visit the United States in October on his way back to Japan. He will lecture at several places while he is here.

DR. EMILE HOLMAN, professor of surgery in the school of medicine of Stanford University, San Francisco, has been granted leave of absence during the autumn quarter to serve as visiting professor of surgery in Peiping Union Medical College, Peiping, China. During August, Dr. Holman visited Japan and gave lectures and clinics at the Severance Union Medical College, Seoul, Korea.

FATHER STEIN, S.J., has been named as director of the Vatican astronomical observatory. He succeeds the late Father John George Hagen.

THE Society of American Bacteriologists will hold its annual meeting under the presidency of Professor S. Bayne-Jones at the Massachusetts Institute of Technology from December 29 to 31, 1930. Dr. Barnett Cohen, of the Johns Hopkins School of Medicine, is in charge of the program.

THE regular annual two-day meeting and conference of the committee on electrical insulation of the division of engineering and industrial research of the National Research Council will be held on November 7 and 8, 1930, at the Bureau of Standards, Washington, D. C. The meeting will include three technical sessions at which eighteen informal papers reporting

current progress in dielectric and insulation research will be presented. On Friday evening, November 7, there will be a subscription dinner, followed by an illustrated lecture by a prominent physicist on recent advances in dielectric theory. A complete statement of the program will be announced shortly. Dr. J. B. Whitehead is chairman of the committee.

THE board of canvassers of the American Pharmaceutical Association, composed of T. C. Marshall, J. B. Pendergrast and Sinclair Jacobs, announce the election of the following for officers of the association: *President,* Walter D. Adams, Forney, Texas; *first vice-president,* J. G. Beard, Chapel Hill, N. C.; *second vice-president,* J. W. Dargavel, Minneapolis, Minn.; *members of the council* (for three years), H. A. B. Dunning, Baltimore, Md.; S. L. Hilton, Washington, D. C.; Ambrose Hunsberger, Philadelphia, Pa. These officers will be installed at the next annual meeting of the association which will be held in Miami, Florida, from July 28 to August 1, 1931. Mr. G. H. Grommet, who has been elected local secretary, is also secretary of the local committee on arrangements of which J. K. Klemmer is chairman and I. Clif. Smith is treasurer. The 1932 meeting will be held in Toronto, Canada, and will be a joint meeting with the Canadian Pharmaceutical Association.

THE National Association for Savings and Economy, of Istanbul, Turkey, will hold a farm congress on January 5, 1931, to determine the needs of the agriculturists.

A THREE-DAY conference of delegates from New South Wales agricultural societies and kindred organizations has been held at Sydney, Australia.

THE U. S. Civil Service Commission announces an open competitive examination to fill the position of senior geophysicist in the Bureau of Mines, Department of Commerce, for duty at Baltimore, Md. Applications must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than October 22, 1930. Competitors will not be required to report for examination at any place, but will be rated on the subjects of education and experience, and on publications, reports or a thesis. Applicants must have been graduated with a degree from a college or university of recognized standing. Applicants must also have had certain additional experience or education. Full information may be obtained from the U. S. Civil Service Commission, Washington, D. C., or from the secretary of the U. S. Civil Service Board of Examiners at the post office or customhouse in any city.

THE Chemical Foundation of New York has given $100,000 to the government to endow a fellowship in the newly established National Institute of Public Health for research in the chemical industry. W. W. Buffum, general manager and treasurer of the foundation, presented the contribution to Andrew W. Mellon, Secretary of the Treasury. Francis P. Garvan, former alien property custodian, is president of the foundation.

THE Bouisson-Bertrand Institute, at Montpellier, France, has been authorized by the government to accept an annual subsidy of $10,000 from the Rockefeller Foundation. The money will be spent upon research into the cause and if possible promote the cure of Mediterranean fever, also known as Maltese fever.

AT the recent commencement exercises of the department of anatomy, portraits of seven of i's former and present faculty members were presented to Western Reserve University School of Medicine: Drs. George W. Crile, Roger G. Perkins, Isaac Newton Himes, Charles F. Hoover, Frank Emory Bunts, Carl A. Hamann and George Neil Stewart.

THE list of British civil list pensions for the year ending March 31 last includes £90 to Mrs. Maude Mary Buckman, in recognition of the services rendered by her husband, the late Mr. Sydney Savory Buckman, in the sphere of geology, and £70 to Miss Katherine Mary Lovell Gamgee, in recognition of the services rendered by her father, the late Professor Gamgee, to medicine and physiology, and of her work in connection with public health.

DR. OWEN H. WANGENSTEEN, of the University of Minnesota Medical School, has received a $600 grant from the committee on scientific research of the American Medical Association for the continuance of his studies on intestinal obstruction.

THE Oxford University Press has arranged to continue *The Quarterly Journal of Mathematics* and *The Messenger of Mathematics* as a single journal, to be called *The Quarterly Journal of Mathematics* (Oxford Series). The editors will be T. W. Chaundy, E. G. C. Poole and W. L. Ferrar.

AN intensive and exhaustive study of Pennsylvania anthracite coal will be begun at once in three important universities, according to announcement made to-day by Noah H. Swayne, executive director of the Anthracite Institute. By arrangement with Lehigh University, Professor Homer G. Turner, assistant professor of mineralogy, has been appointed director of anthracite research and will devote much of his time during the next few years to that work.

SEVERAL hundred specimens of plants of the coffee family, sent to the Field Museum of Natural History

for study by the Botanical Garden of Leningrad, have been determined by Associate Curator Paul C. Standley, of the botanical staff of the Field Museum. Included were many specimens collected more than one hundred years ago and some obtained by the French botanist Aublet, who published in 1775 the first important work relating to the plants of South America. The Botanical Garden of Leningrad also sent to the museum in exchange more than one hundred plants of the same family, collected in Brazil by the well-known botanist Riedel and of great historical importance.

DISCUSSION

EUPHANY

In the current number of the *British Journal of Psychology,* Professor T. A. Pear proposes to introduce the term "euphasia" to designate "the ability for deliberate and adequate statement of fact." One recognizes at once the great need for a technical term for this concept, but the term "euphasia" is unavoidably associated with terms of the same root in mental pathology, such as aphasia and disphasia. To avoid this, I wish to substitute the word "euphany" with its legitimate adjective "euphanious," the term being derived from the Greek word *phaino* which means "to say," "to reveal" or "to make clear," strengthened by the prefix "eu."

The term "euphany" may, therefore, be defined in terms of two concepts, namely, deliberation and adequacy of statement. Psychologically, deliberation involves a clarifying of percepts and concepts involved; abstraction in the form of clearing the ground by reviewing upon critical evidence all the plausible alternatives; generalization in which the issue is made sharp and clear by rejectior of irrelevant issues; the recognition of meaning in the establishment of the relevancy of the clarified concept, and finally, decision which results in the expressed judgment or act. The term "adequate" merely reenforces this procedure by applying it to the one issue in hand.

The need for this word is felt, particularly in the statement of the goal of higher education and in the evaluation of progress toward this goal, as euphany is the principal objective of training in scholarship and the power of expression. The end of all science is classification, and euphany is the capacity for adhering rigidly and deliberately to classified concepts. In it the educator should set a model. To say that speech or writing is euphanious is to pay it a high and specific compliment.

C. E. SEASHORE

UNIVERSITY OF IOWA

NOMENCLATURE

MUCH of our discussion about nomenclature is apt to be beside the point, as very few workers have a conception of the enormous task confronting the systematists. The number of insect species living in the world at the present time has been variously estimated at from 1,000,000 to 10,000,000, and one person's guess is as good as another's. An even better estimate may be secured by taking a census of a smaller group. I have been interested during the last twenty years in making an index to the literature dealing with the insects of the order *Homoptera,* families—Cicadidae, Membracidae, Cercopidae, Cicadellidae (Jassidae) and Fulgoridae. This index now occupies one hundred thirty-two 3 x 5 drawers in my office. A couple of stenographers, an assistant and I are too busy in our spare moments indexing the new literature as it is published to count the number of cards in this index, but making a rough and ready estimate, there are about 150,000 references to about 30,000 species distributed in 5,000 genera. This is a small order of insects, and it is doubtful if considering the world as a whole we know more than one third of the species. The European fauna has been fairly well studied, so has that of North America, north of Mexico; but Mexico, Central America, the West Indies, South America, Africa, Asia, the East Indies and Australia have barely been touched. I am bold enough to predict (because I will be dead and this note will be forgotten long before the task is completed) that the discovery of the remaining species will change our concepts of things nomenclatorial more than they have been changed during the past 172 years. Yet, Linnaeus described in this group of insects in his famous Tenth Edition 1 genus and 42 species! In spite of these facts we hear on every side a plea for the return to the Linnean concept of genera and stability in nomenclature. What kind of a genus would it be with 100,000 or even 30,000 species in it? And how can there be any stability when only about one third of our territory is known? Why expect stability in anything? Even the material universe around us is not stable. Thirty years ago as a student I was told that the atom was the ultimate particle of matter beyond which there was nothing; yet to-day we float in a sea of electrons and protons. And only day before yesterday I listened to a physicist lecture on the wave theory of matter. No! There will be growth in our ideas of taxonomy and systematics as long as there are taxonomists and systematists.

In the Homoptera, Linnaeus knew nothing about wing venation, genitalia and other morphological

characters. But to-day no careful student would think of describing genera and species in this group without careful study of these characters. What of the future? Just as important characters await discovery, most, if not all, of our present concepts of genera and species will fade away before this broader knowledge like mist before the rising sun. In talking to some zoologists it seems to me that their conception of stability consists of a desire for the retention of the names that they learned, some of them 60, some 40, some 20 and some 10 years ago.

I remarked to a friend the other day that the whole thing reminded me of the embarrassment that we are sometimes confronted with in these days of easy divorce. We can never be sure whether the lady we are talking to is Mrs. Smith or Mrs. Jones, but we can be sure that it is the same person we knew for a long time as Mrs. Johnson. New names are embarrassing and confusing, but the true systematist can offer no escape from this confusion.

There is another idea prevalent in the minds of many biologists that needs to be corrected. For want of a better name I shall call this the pill-box in nomenclature. It runs something like this. If our conception of an animal fits a certain size pill-box it is a species; if it fits a larger box it is a genus. All that remains is to fit the animals in their appropriate boxes. All systematics degenerates, therefore, in the minds of many biologists to a kindergarten game of fitting triangles, squares, circles, *et cetera,* into appropriate openings. But the matter is hardly as simple as this. No one has defined the terms, genera and species. Concepts, especially concepts as varied as these, do not lend themselves to being crammed into pill-boxes. These objects that we call species are about as complex by comparison as the mosaic on the stairway of the Library of Congress. And it is, therefore, a little difficult to fit these complicated patterns into the appropriate openings in the general scheme of things. Stability won't do it. Stability simply puts many a square peg in a round hole and *vice versa.*

Dr. Gleason's two principles[1] won't do it, for no group of more than two systematists would ever agree as to what constituted a forgotten or nearly forgotten name. For the lines separating names in use, nearly forgotten and forgotten are as non-existent as other lines in nature; they are man made and, like all other boundaries, subject to shifts. Hence, good-bye stability. The second principle, that of making no changes unless the author believes he is thereby adding to the sum total of human knowledge, may be needed in certain fields of science, but in systematic zoology—never. All systematic zoologists (even the mythical Dr. X who discovered that the name of the cow should be *Equus caballus* and the name of the horse should be *Bos taurus*) know that they are adding to the sum total of human . . . (excuse me, I almost wrote confusion) knowledge.

[1] SCIENCE, 71: 459.

Z. P. METCALF

NORTH CAROLINA STATE COLLEGE

ADMIRAL WALKER'S APPRECIATION OF THE WORK OF COLONEL GORGAS

MY attention has to-day been called to an article in SCIENCE for May 30, 1930, written by Dr. John F. Stevens, formerly chief engineer of the Panama Canal, which is couched in such vague terms that I feel he may be doing an unintentional injustice to my father, Rear Admiral John Grimes Walker, the first chairman of the Panama Canal Commission.

Dr. Stevens writes of "the condition of affairs on the isthmus during a part of the year 1905" and speaks of his arrival there in July of that year and what he then found to be the situation—"the then chairman of the Isthmian Canal Commission accompanied me on my first visit to the isthmus, remaining there but five days, as the situation did not appeal to him. . . . Neither the Governor nor the chairman had the least faith in the efficacy of the mosquito theory—at least they so emphatically advised me at once, and their actions confirmed their words."

As the commission of which Admiral Walker was chairman resigned in a body on March 30, 1905, these remarks evidently do not apply to him but to his successor in office; as, however, few people are likely to remember the exact date of the formation of the new commission and as Admiral Walker's name has been long and widely connected, not only with the Panama Canal Commission but also with the preceding commissions which carried out all the vitally important preliminary investigations and studies, I feel that Dr. Stevens' omission of all names in making the foregoing statements is extremely misleading.

Admiral Walker had followed with deep interest Colonel Gorgas' wonderful work in ridding Cuba from yellow fever and was so firmly convinced of its value that when President Roosevelt sent for him and offered him the chairmanship of the commission being formed to build the canal the first condition he made was that Colonel Gorgas should be put in charge of the medical and sanitary work on the isthmus. As to the reference to "the then chairman's" stay of only five days on the isthmus "as the situation did not appeal to him"—to any one who knew Admiral Walker this in itself would prove that Dr. Stevens was not referring to him, for he was on the isthmus

many times in connection with canal matters, spending months at a time there, often living in tents in the jungle in order to know at first hand the problems along the proposed routes.

I am collecting material for a sketch of my father, but as I sail for Europe this week I have put all papers in storage and can at present only state the facts as known to myself, the only bit of corroboration at hand being a sentence from a report to Hon. William H. Taft, Secretary of War, dated March 16, 1905, as follows: "The Commission . . . moreover feels itself under obligation not only to provide screens for all buildings owned or controlled by it, but would like to see all buildings where screens would be of any service suitably screened."

I should be glad if you could find space for this letter in order to correct any possible misconception of Dr. Stevens' meaning.

Frances Pickering Thomas

Boston, Mass.

SCIENTIFIC BOOKS

Die Phylogenie der Pflanzen. Dr. Walter Zimmerman, University of Tübingen. Jena, Verlag von Gustav Fischer, 1930.

This is one of the comprehensive works which are a feature of German scientific activity at the present time. It deals with the subject of the evolution of plants, particularly the higher plants, in a thorough fashion from the standpoints not only of morphology, anatomy and development, but also what is rarer, from the standpoint of fossil plants. It is dedicated to Graf Zu Solms-Laubach.

The volume consists of about 450 pages, only some 50 of which are devoted to the Thallophytes. This apparent discrimination against the lower forms arises out of the historical basis of the volume under consideration. Since the record of the lower forms is extremely imperfect, they naturally do not supply abundant material for this volume. About 400 pages are given over to the consideration of the Cormophyta. About 50 pages are devoted to general problems such as the structure and combination of organs, the differentiation of organs, the development and differentiation of the stele and wood, and to reproduction. Under the Cormophyta are included the Bryophyta, which are very briefly considered. Following is the division Psilophyta, to which the author appends the Asterophyta and Psilotales. The third division comprises the Lycopsida, including the forms which are now clearly recognized as coming under this comprehensive heading. The fourth division comprises the Articulata, which are equivalent to Dr. Scott's Sphenopsida. Under this group are arranged the Hyeniales, Pseudoborniales, Sphenophyllales, Cheirostrobales and Equisetales, which are divided into three families, the Asterocalamitaceae, Calamitaceae and Equisetaceae. Next comes the division Pteropsida, including the Filicinae—Primofilices, Eusporangiatae, Osmundales, Leptosporangiatae and Hydropterides. Follow the Gymnospermae, including Pteridospermeae, Cycadophyta, Ginkgophyta, Cordaitales, Coniferae and Gnetales. This chapter is most interesting because it correlates to a large degree the anatomical, morphological and paleobotanical work done in recent years. The treatment of the Conifers indicates the confusion of opinion which still prevails in that field. The botanical world will await with keen interest the complete publication of the investigations and views of Florin and Walton in this important field, since the Conifers, on account of their long duration in geological time and present good state of development, constitute the most important of all biological documents from the evolutionary standpoint. The unchallenged antiquity of the araucarian Conifers no longer prevails and the next few years are likely to see very fundamental changes in this important field. The third division of Pteropsida comprises the Angiosperms and reflects our doubts and difficulties regarding this extremely important group, concerning the origin of which we have scarcely passed beyond Darwin's statement of horrible mystery. Naturally the difficulties which beset the phylogenetic interpretation of the Angiosperms are very great in view of our almost complete ignorance of their early development.

Another division of the volume deals with the history of floras in which the Algae, the Pteridophyta, Gymnosperms and Angiosperms mark quite satisfactorily the main geological periods. A third main division of the volume deals with general historical laws. Under this heading are discussed the development of characters, ascending and descending evolution, the law of irreversibility, polyphyletic, parallel and convergent evolution, correlative evolution, the biogenetic law, reversions and teratological developments in relation to phylogeny.

The second main division of the volume deals with the so-called causal analysis of phylogeny. Under this heading the author deals with phylogeny as a physiological process with continuous and discontinuous variation and the development of characters suited to the environment. Further he discusses the Lamarckian and Darwinian attitudes towards evolu-

tion, calling attention to the essentially Lamarckian attitude of the genetical group at the present time. He further deals with the difficult subject of the inheritance of acquired characters, a field which has recently assumed renewed prominence in connection with experimental use of radiations. There follows a discussion of the essential principles of Darwinism under the headings of the selective action of the struggle for existence, the accumulation of mutations (variations), the origin of mutations (variations). Next comes a discussion of the limitations of Darwinism and of the problem of the protean character of organic matter. These various discussions end with a summary of the most important results of phylogenetic analysis.

Although the volume is of moderate size, it contains a very large amount of information and is most attractively and comprehensively illustrated. It will be of great value to all students of botanical science who can read the German language with any degree of ease.

E. C. Jeffrey

Botanical Department,
Harvard University

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR MAKING A BIBLIOGRAPHY

Scientific workers generally agree that a bibliography is an essential for good research.[1] Bibliochresis is the first and a fundamental step in the natural approach to a new problem. In many cases there are regularly maintained bibliographies which are available for use, and even though they may be one or two years in arrears, the workers find it possible to supply the lacking material with a few hours' search of the leading publications and annual reports. For example, the bibliographies of North American geology, edited by Nickles and published by the U. S. Geological Survey, have covered the literature in this field for the period since 1785. As specialties within a field develop it has been found necessary in some cases to compile a bibliography for that branch of the science and to keep it up to date by the periodic publication of new lists. Many science departments or individuals of various universities and colleges find it desirable to compile bibliographies which are so arranged that they supplement the published reference lists if such exist. This has been the case in the division of sedimentation of the department of geology at the State University of Iowa. The graduate students as well as the members of the staff interested in this field of geology contribute regularly to this file. During the last two years the writer has been active in compiling a bibliography pertaining especially to the petrography of sediments. The plan used is submitted here in the hope that others may find it helpful, or will make for improvement.

The references which include the complete data regularly given in bibliographies are typed on a fan-fold form in triplicate, with eight sets of cards in series. An 88-pound white ledger Scotch linen paper has been found most desirable. The paper used is thin enough to make good carbon copies, takes little space in the file drawers and is tough and stiff enough to withstand harder use than the average grade 3 x 5 file card. Sheets 24 x 15 inches are perforated accurately so as to make twenty-four 3 x 5 inch cards in three vertical rows of eight each. The 5-inch dimension of the card times three cards utilizes the 15-inch dimension of the original sheet, and the 3-inch dimension of the eight cards fills the 24-inch dimension. When ready for use the large sheets are folded along the two 24-inch perforations making a triplicate form 5 inches wide and 24 inches long. Carbon copying sheets 5 x 24 inches are used. This makes it possible to type eight references in triplicate with the one operation of folding, placing carbon paper and inserting in typewriter. When the typing is completed the cards are torn apart, or cut along the perforations with a large knife paper trimmer, keeping the three copies of the reference together. When ready to file, the three cards are torn along the perforations and distributed in any manner desired. The advantage of three copies of the same reference, and the speed a good typist can make in copying a large number of references when he has only to insert a new set of forms for every eight bibliography references, more than pay the small cost of the forms.

The same type of triplicate fan-fold form is used in a 5 x 8 inch size, seven in vertical series, for a file of definitions of sedimentary rocks. In fact, the general idea was worked out first when the subcommittee on the classification of sedimentary rocks, of the committee on sedimentation, National Research Council, wished to make three identical sets of rock definitions.

In actual practice in this department, the graduate students interested in sedimentary petrography and the writer in his own research accumulate the bibliographical data on whatever type of paper, card or

[1] See W. A. Hamor and L. W. Bass, "Bibliochresis," Science, n. s., 71: 375–8, April 11, 1930.

other arrangement is most convenient at the time. When a hundred or more references are on hand they are given to a typist who makes the copies on the form described and arranges the wording according to a uniform plan. Often the bibliography maker writes a short abstract of the article, or comments on its most useful information, and these statements of from 75 to 125 words are copied on the cards.

The system of filing used by the writer is an attempt to place the cards so they will be most readily found when looking through the index for particular articles or when making a study of a specific subject. The first or original card of each set is placed in a general file arranged alphabetically by authors; the second card (a carbon copy) is placed in its proper alphabetical order according to the type of rock or mineral or texture described; the third card (second carbon copy) is placed in a miscellaneous group, arranged alphabetically, under such headings as "chemical analyses," "environments of deposition" (with subdivisions as lakes, rivers, marine, littoral, swamp, etc.), "laboratory methods," "mineral analyses" and many others. Oftentimes the third card is placed under a separate subheading of the division which contains the second card. For instance, the cards covering the article by Takahashi, on the "Significance of Micro-crystals of Carbonates in Bituminous Shales," would be distributed (1) in "T" of authors' file, (2) in "shales" of the rock division of the file and (3) in "carbonates" in the same division. Another article, by Kindle, "A Comparative Study of Different Types of Thermal Stratification in Lakes and their Influence on the Formation of Marl," would be found by looking in the author index or under "marl" of the rock division or under "lakes" of the environment of deposition class of the miscellaneous division. Often the word used for filing purposes, or the method of classification does not appear in the title of the article but will be given in the abstract of the article at the bottom of the card. When such is the case, it has been found convenient to underline the word or clew to classification with red pencil. Cards for the article by Ross on "Altered Paleozoic Volcanic Materials and their Recognition" would be found in the author index, one under volcanic rocks and the third one in the mineral analyses class, this being an important feature of the article.

The writer recognizes that the brief description does not show clearly how every type of reference would be filed, or that the method is entirely foolproof, but he knows from experience that he can usually find a bibliographical reference in a short time, if it is in the file, without the delay of going through an authors' index.

A. C. TESTER

STATE UNIVERSITY OF IOWA

TEST PAPERS FOR DETECTING MAGNESIUM

A CONVENIENT method for carrying out the new organic test for magnesium is by means of a spot reaction on filter paper impregnated with the reagent. The test papers may be prepared as follows. White filter paper is immersed in a 0.01 per cent. solution of para-nitrobenzene-azo-resorcinol[1] (ortho, para-dihydroxy-azo-para-nitrobenzene) in alcohol and hung up to dry. When dry cut into pieces of about four square inches and preserve in amber bottles. To perform the test, one drop of the slightly acid solution to be tested is placed in the center of the test paper and allowed to dry. Immerse paper in a dilute sodium hydroxide solution (about 1 per cent.). In the presence of magnesium a blue spot will show in a reddish field. If the test drop contained a large amount of acid the spot will first be yellow. The reaction as performed is sensitive to about 0.005 milligrams of magnesium (one drop of a solution containing 0.1 milligram of magnesium per cc). The limitations on this procedure are the same as those noted before,[2] nickel and cobalt giving similar colored spots and large amounts of ammonium salts and organic matter reducing the sensitivity.

IRWIN STONE

NEW YORK, N. Y.

SPECIAL ARTICLES

LIVING MICRO-ORGANISMS IN THE AIR OF THE ARID SOUTHWEST

NUMEROUS living micro-organisms are present at times in the air in southern Arizona. Recently the writer exposed from aeroplanes sterile agar plates and spore traps during flights primarily intended to afford information concerning the movement of the spores of wheat rusts. Two agars were used: Nutrient, pH 7.2, and potato, pH 6.8. Exposures were uniformly two minutes in length. Some of the results are given in the following table.

No spores of wheat rust were found, but further trials may discover them. Among the fungi were species of Aspergillus and Penicillium, Macrosporium, Alternaria, Cladosporium and one yeast. White and

[1] Purchasable from Eastman Kodak Company, Rochester, New York, or may be prepared by detailed method given by Stone, *Chem.-Analyst*, 19: 6, May, 1930.

[2] Riugh, *J. A. C. S.*, 51: 1456, 1929; Engel, *ibid.*, 52: 1812, 1930.

April 11, 1930

Plane, Fokker, trimotor; weather clear, sunny; surface air temperature, 28° C.; air temperature aloft, 24° C. at 5,000 feet and 22° C. at 5,800 feet; surface wind S., 5.5 miles; wind at 6,000 feet S.S.E., 8 miles.

Plate no.	Medium	Altitude above sea-level, ft.	Speed of plane, M.P.H.	Number of colonies: Fungi	Bacteria	Total
1	Pot.	5,500		19	222	241
2	Nutr.	5,700	110–115	10	103	113
3						
4	Nutr.	5,500–5,800		11	165	176
5	Pot.	5,200	120	25	151	176
6	"	5,000	125	23	103	126
7	Nutr.	4,800–5,000		6	66	72
8	Pot.	4,300–4,500	115–120	20	43	63
9	"	2,300–1,500		38	158	196
		April 12, 1930 Same plane; weather clear, sunny, quiet.				
10	Nutr.	3,100–3,700	95–100	50	454	504
11	"	6,000–6,400	100–105	1	211	212
12	"	7,000–7,200	100–110	8	95	103

gray colonies of bacteria predominated, although there were numerous chromogens. The fungi and bacteria will be tested for pathogenicity on the most important economic plants of Arizona.

The viability of micro-organisms in arid regions has not been extensively studied, possibly because institutions of research usually are not located in or near deserts. On this subject the opinion is widely held that bacteria and fungi are quickly killed by the prevailing conditions of light, heat and dryness. No doubt the almost proverbial health of the native human inhabitants of arid regions has something to do with this belief, although their health is probably the result of the stimulating effect of outdoor life rather than of the absence of germs. At any rate, parasitic plant diseases are common, and bacteria and other micro-organisms are abundantly present.

The abundance of living organisms in surface dust and soil in Arizona has been shown by two investigators. In 1919 Miss Mary Estill,[1] now Professor M. E. Caldwell, isolated more than thirty species of bacteria from dust obtained in the streets of Tucson and adjacent country. Later the same investigator[2] showed that the bacterium of tuberculosis retained its virulence in dust, outdoors, for as long as seventy-two hours. Dr. Laetitia M. Snow[3] in 1926 studied the bacterial flora of wind-blown sand obtained near Tucson and isolated about eight times as many organisms as were later found to live in the wind-blown sand of dunes at Sandwich, Massachusetts.

That the micro-organisms in air ride on particles of dust has long been known. Dust and wind-blown sand carrying bacteria, fungal spores and even pieces of mycelia are lifted upward by the spiral "twisters" and the wind-storms of arid regions. Granted that the organisms remain alive during the aerial movement, the distance that they are carried becomes an important question. This will depend upon the height to which the dust and sand ascend as well as upon the air current. If the germ-laden particles reach the upper air currents the distance may be great. During the flights made by the writer, a maximum altitude of 7,200 feet above sea-level or 5,700 feet above the surface was attained and living bacteria found. Therefore dust must be lifted to that height. Redway[4] states that wind-blown dust rarely ascends over 2,000 feet. On the other hand, MacMahon,[5] an aviator, says of a South American trip, "On still another flight, while crossing the pampas, a sandstorm blowing 6,000 feet into the air forced us to fly blind for a time."

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THE RELATION OF THE THYROID AND PITUITARY GLANDS TO MOULTING IN TRITURUS VIRIDESCENS

STOPPING of the periodic moult in *Triturus viridescens* can be brought about by extirpation of certain of the endocrine glands. For example,[1] thyroidectomy inhibits skin shedding, and animals lacking thyroids become gradually blacker and blacker as layer after layer of cornified cells is formed and not sloughed off. This reaction is usually noticeable within two weeks (depending somewhat on the temperature) and by four weeks is markedly evident. Hypophysectomy also causes a cessation of moulting, and the experiments done by two of the authors (Adams and Kuder) show that the pars anterior is the part intimately involved in this result. Removal of it alone produces the same effect (lack of moulting and

[1] Mary Howard Estill, master's thesis, University of Arizona.

[2] Mary Estill Caldwell, "Viability of Mycobacterium Tuberculosis in a Semi-arid Environment," *Jour. Infect. Dis.*, 37: 465–472, 1925.

[3] Laetitia M. Snow, "A Comparative Study of the Bacterial Flora of Wind-blown Soil: I. Arroyo Bank Soil, Tucson, Arizona," *Soil Sci.*, 21: 143–161, 1926; "A Comparative Study of the Bacterial Flora of Wind-blown soil: II. Atlantic Coast Sand Dunes, Sandwich, Massachusetts," *Soil Sci.*, 24: 39–48, 1927.

[4] Jacques W. Redway, "The Dust of the Upper Air," *Ecology*, 2: 104–109, 1921.

[5] Harold E. MacMahon, "Blazing New Trails," *Liberty Magazine*, p. 47, May 3, 1930.

[1] A. E. Adams and L. Richards, "The Effect of Thyroidectomy in *Triturus viridescens*," abstract, *Anat. Rec.*, 44: 222, 1929.

blackening of the animal as the layers of cornified skin remain in place) as removal of the whole gland.

The similarity of the appearance of the specimens of *Triturus viridescens* after thyroidectomy or hypophysectomy suggests that there may be some interdependence of these two glands in the control of the moulting process, and a series of experiments was devised to answer the following questions. (1) Does thyroid removal in itself cause the inhibition of moulting or does it affect the pituitary in some way so that it is a maladjustment on the part of the latter rather than absence of the former that is at the root of the difficulty? Or (2) does hypophysectomy in itself directly cause the inhibition or does its absence affect the thyroid in some way so that it is essentially an upset of the thyroid that is the real trouble?

The tests were made by grafting thyroid glands (in a few cases by injecting thyroxin) or pituitary glands (whole glands or pars anterior only) into (1) thyroidectomized, (2) hypophysectomized or (3) hypophysectomized-thyroidectomized animals, all of which had stopped moulting after the respective operations and were very definitely black with the piled up cornified epidermal layers. Briefly the results were as follows. Thyroid glands of normal animals transplanted into thyroidectomized or hypophysectomized or hypophysectomized-thyroidectomized animals will induce a complete moult of the many-layered cornified epidermis within a short time, usually as early as two days after the transplant. Transplantation of the thyroids of hypophysectomized animals into hypophysectomized or thyroidectomized animals will have the same effect. Injection of thyroxin or immersion in it will cause moulting in thyroidectomized animals, and injection is likewise efficacious in hypophysectomized ones, but it has not yet been tried on ones from which both glands have been removed. Pituitary glands (whole glands or anterior lobes) transplanted into thyroidectomized or hypophysectomized-thyroidectomized animals (ones from which the thyroids and pituitary had been removed simultaneously or from which the thyroid had been removed just prior to grafting) will not bring about the moult. (In a few cases thyroidectomized animals, which had blackened somewhat, moulted after pituitary grafts, but a careful search always revealed the presence of some thyroid follicles.) If thyroids are transplanted into these animals subsequently to the pituitary grafts, the animals shed their skins. Pituitary glands (whole glands or anterior lobes) transplanted into hypophysectomized animals will induce moulting within a few days.

This combination of results at once suggests that the key to the explanation of the inhibition of moulting lies primarily in the thyroid gland. Thyroid grafts are able to stimulate moulting in all the operated animals (thyroidectomized, hypophysectomized or hypophysectomized-thyroidectomized) because they supply the essential hormone, but pituitary grafts are able to do it only in hypophysectomized animals where the thyroids are still present and can be activated by such grafts. In the thyroidectomized animals an athyroid condition has been produced, and although cornification of the skin continues, sloughing is discontinued. In the hypophysectomized animals, a hypothyroid state (possibly a functional athyroidism) has been brought about by the removal of the pituitary gland (either whole gland or pars anterior only) and this hypothesis is supported by a histological study of the thyroids in such animals. Instead of the usual cuboidal cells bounding the follicle and a moderate amount of colloid within the follicle, the cells are flattened and a large amount of colloid distends the follicle. However, these thyroids contain the active hormone because when removed from hypophysectomized animals and retransplanted into the same animal, moulting occurs just as quickly (in two days) as if thyroids from normal animals had been used. Such thyroids also will cause moulting in thyroidectomized animals.

From these experiments it seems probable that the thyroid hormone is essential for the normal moulting mechanism and that the secretion of the anterior lobe of the pituitary in some way regulates the thyroid gland. A full account of these experiments will appear later.

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SPECIALIZATION IN SCIENCE[1]

By Professor FRANCIS RAMALEY

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IN the organic world it is the generalized type which gives rise to higher forms while extreme specialization means an end of progress. To illustrate from the field of botany: the mosses have been called an evolutionary failure for, although they have adopted a thousand forms, these all are too highly specialized to allow of really important advance. In the whole moss class there is a clinging to certain particular features—no freedom to produce or even to suggest anything non-moss like. Mosses have rung changes upon non-essentials but have always kept their own special pattern. The liverworts did not thus specialize but retained their plasticity, varying in many directions and at last giving rise to the remarkable Anthoceros (horned liverwort), which is almost a lycopod. And although the paleontologists may not find the "missing link" which connects liverworts and lycopod there can be no doubt that the generalized liverworts, not the specialized mosses, gave origin to the next plant division.

Among animals, also, specialization stops progress. Neither the intelligent and betrunked elephant tribe, nor the swift-footed, one-toed horse, nor the cunning members of the wolf and dog family with their great body specialization and highly developed sense organs produced the "lords of creation." Rather was it some simple creature with primitive hands and feet and jaws which began that great advance leading by one path to the grinning chimpanzee and ferocious gorilla or, by another turn, past a long series of half-human beasts to present-day man. Here, as always, the specialized types early reached a limit beyond which they could not go while generalized forms retained the

[1] Condensed from the address of the retiring president of the Southwestern Division of the American Association for the Advancement of Science, eleventh annual meeting, Tucson, Arizona, April 23, 1930.

power to advance. Too great specialization may even lead to extinction. The cephalopods of Mesozoic times carried to an extreme their coiling and twisting. Their complicated suturings which rival the most elaborate arabesque ornament may have suggested progress, but with all their marvelously intricate patterns these once important creatures became extinct and only their poor relations, the simple squid and devil-fish, remain. When environmental conditions change the survival chances of specialized types diminish. It needs no argument that a man who could do nothing but make horseshoes, although very much needed in the Victorian period, would have little call for his skill in these days of good King George the Fifth.

It is a fashion just now of newspaper columnists to make fun of the many specialties in medicine; but are these any narrower than the enclosed and cultivated fields in the general sciences? As a botanist I must associate not with other botanists but with plant physiologists, plant ecologists, geneticists, biometricians, phycologists, mycologists and phytopathologists. Perhaps this specialization is not so extreme as it sounds; it may be that these worthy men of science are really broader than they like to appear. But our universities seem not to be working for breadth. Many professors, although themselves broadly trained, permit students to give all their time to a small field of study. I suggest that embryonic and larval scientists be encouraged to cultivate also their "minor" subjects. At the present time there seems to be a lessening in breadth of requirements for graduate degrees. Some schools allow the minor to be taken in the same department as the major or else more honestly state that no minor at all is required. Others, and even supposedly reputable ones, grant the Ph.D. degree to students who are unable to read French and German.

Specialization has come to stay. The family physician, the old-fashioned naturalist and the general student of physical sciences give way to those who confine their work to a particular and narrow field. Should not these specialists, however, have a solid foundation, a broad background, for their individual studies? Should the chemist be merely a chemist or should he have some knowledge of other branches of science? Shall the geologist be a geologist and nothing more? Will the physicist be a better or a poorer physicist if he knows some chemistry? Is it not true that he who neglects broad fundamentals, however proficient in some specialty, may fumble long and never find the key which opens the door of opportunity?

Perhaps it is not altogether the fault of the university professor that his graduates lack the broad training which I claim to be so important. Personally, I find it difficult to make students, whether undergraduates or graduates, elect courses outside their major department. They become acquainted with the general facts of their own science and with the instructors and their methods; they fear to set out upon an unknown road lest they be not able to travel it in safety. These observations refer not so much to the "weak brothers," for they may try a new subject hoping that it will be easy, but they point rather to the so-called "good" students who have done well yet are such timid souls that they shrink from the untried. I find very little zest for intellectual adventure among the "flaming youth" of to-day who like best the familiar scenes and who do not care to seek out that which lies beyond accustomed limits.

Since specialization is necessary, how may the ills of over-specialization be minimized? If workers in different sciences are brought together in one organization each is broadened by contact with others. There may be mutual help for those too narrowly trained, whether employed in a university or an endowed research institution or in an industrial plant. Young persons entering upon a scientific career need to be reminded of this great advantage in working with others. The solitary science worker lacking the stimulating influence of companionship in research has a hard struggle, and especially hard if his interests are greatly circumscribed. The annual gatherings of societies are of high value. We older folk know this from experience but youngsters need to be told. This meeting of the Southwestern Division of the American Association for the Advancement of Science brings before us many problems and achievements of our fellow laborers in other fields. It gives us breadth of vision and keeps us from thinking too highly of ourselves and of our own specialties.

It has been my attempt to show the need of breadth of learning and the danger of one-sidedness. But let me not be misunderstood! I know and you know that the great scientific advances of the future will come from the work of the specialist. Yet it seems reasonable to expect that the specialist with a wide background of scientific knowledge will achieve most. Those of us now in the harness may well urge upon the rising generation a longer scholastic preparation and a more generous grounding in basic science. May these neophytes, as they advance in their studies and in their professional careers, retain a sympathetic interest in all knowledge even while they press forward in their own straight and narrow path!

ECOLOGICAL ASPECTS OF THE TRANSITION FROM OLD FORESTS TO NEW[1]

By THORNTON T. MUNGER

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We are to-day almost in the geographic center of the most outstanding coniferous forest region of the world, the region between the Pacific Ocean and the summits of the Cascade and Sierra Mountains from northern British Columbia to central California. Here most of the land surface was covered originally with a dense, luxuriant growth of trees and associated shrubs and lesser plants. With an insular climate peculiarly favorable to coniferous trees, the forests are notable for the great height and diameter of the trees. The big trees of this region are the colossi of the vegetable kingdom, superb in their graceful proportions and in their enormity. Besides being the largest, they are probably also the oldest members of the plant or animal world. These forests are of great economic significance, both present and prospective, not only to the region in which they occur but to the whole country.

In the coastal strip in western Oregon and Washington alone, 125 miles wide from the Cascades to the ocean, from 350 miles north of Eugene to 150 miles south, which I will call the Douglas fir region, there is 500 billion feet of timber, or a quarter of that in the entire United States. This region produces annually 10 billion board feet of lumber, or more than a quarter of that cut in the whole United States. It is used by the factories and house builders from California to New England, and by the countries across both oceans. Here the principal industry is the conversion of virgin forests into useful products, and that process is going on apace.

It is appropriate, therefore, at a meeting here in the heart of this forest region that scientists give thought to the many biological and physical problems that bear on the natural life history and perpetuation of the forest.

The particular phase of this subject which I have been asked to discuss is ecological aspects of the transition from old forests to new. In treating this subject I will discuss only the so-called Douglas fir region of western Oregon and Washington, the most important economically and perhaps the most interesting scientifically of all the Pacific Coast forests. It has, however, much in common with the redwood and the sugar pine forests to the south and with the spruce-hemlock belt to the north.

[1] Presented at a Symposium on Forest Trees, Pacific Division, American Association for the Advancement of Science, at Eugene, Oregon, June 19, 1930.

The transition from old forests to new is a process which has been going on through the ages. In the natural woods there is a constant shuffling of the age groups and a shifting of the species represented. Never is the forest static. The trees of a forest make their growth, mature, become senile, fall a prey to disease, tempest or fire, and the places they have vacated are taken by the next generation of the same or other species. The forest goes on forever. In the untrammeled wilderness free from interference by man the transition from the old forest to a new is usually made successfully, though often piecemeal and not without delays.

But when man enters the scene with fire and with axe the replacement of the old forest by a new is precarious and may or may not be effected, or the new forest may not be at all of the same character as that which would have succeeded under primeval conditions.

I want first to sketch rather briefly the normal life cycle of the forests of the Douglas fir region and point to some of the natural factors that shape their destinies. Following that I want to bring man's activities into the picture and show how he may very radically affect either for better or worse this transition from old forests to new.

Let us imagine ourselves back in the days before Lewis and Clark, when there were no lumbering operations, and the natural elements and a few aborigines held full sway. Written historical description goes back but a short time, but forests have a way of writing the biography of each individual tree in a very complete and accurate fashion by means of annual rings. So it is easy to reconstruct the primeval forest of the past and to trace its transitions up to the present.

In the region of which I speak the principal actors in this forest drama of the past are Douglas fir, western hemlock, western red cedar and several species of balsam fir. There are other trees of consequence such as Sitka spruce and Port Orford cedar in the fog belt, western white pine here and there, yew as an understory, and various hardwoods in specialized localities. Douglas fir is intolerant of shade and ordinarily grows in even-aged stands, not reproducing in small openings between or underneath the mother trees. All the other species—hemlock, cedar and balsam firs—are tolerant of shade, reproduce underneath the mother trees, so inevitably tend to form uneven-aged stands.

In a mixed forest of these species left to itself where an old Douglas fir succumbs to senility, the hole that it left in the crown canopy is not adequate for the seeding in of its own kind, but is favorable to the more tolerant hemlock and cedar. So in time the old Douglas firs all disappear, their places are taken by hemlocks, cedars or more rarely balsam firs, and the composition of the forest has changed. This is the normal climax association of all but the driest parts of the region. There are extensive areas within this so-called Douglas fir region which have no Douglas fir, though the soil and climate are admirably adapted to the species. It is absent merely because in the conflict of the centuries the tolerant hemlock and cedar have taken exclusive possession. On these grounds it might be expected that the primeval forests of this territory would all be the climax association—but this is far from the case. The anomaly of the situation is this, that a type map of the forests of Lewis and Clark's day would probably show 65 per cent. by volume to be Douglas fir. There were probably stands of all ages from one year up and no small amount of timber 100 or so years old. Perhaps 25 per cent. of the pre-white man forest was under 150 years of age.

The explanation for the failure of the climax type to prevail is fire. The positive evidence is ample, if the theoretical evidence were not convincing, that fires have been present from time immemorial and have been a very important ecological factor in the life history of the pre-white man forests.

Fires in this region are apt to be very destructive and therefore have a cataclysmic effect on the life cycle of the forest. Imagine a severe fire hitting an old mixed forest, killing most of the trees over a considerable area and leaving the ground bare and exposed to summer drought. On such an area hemlocks, cedars, etc., can not establish themselves, but Douglas fir can. Result—the burn springs up to Douglas fir almost to the exclusion of everything else and a pure young forest of this species replaces the fire-killed mixed stand. As this young forest develops, hemlocks, cedars and balsam firs appear in the shade of the Douglas fir, sometimes forming a sort of slow-growing understory. As the new forest ages these tolerant interlopers come more and more into prominence and replace the Douglas fir, and the cycle is completed.

Hence it is that the forests that come to us as the heritage of the past are not all or even mostly the superannuated stands of the climax association, but there are young stands and middle-aged stands in which Douglas fir, the most useful species of the association, is always in the preponderance. The forest fire which we now so properly condemn did a good turn in prehistoric times by renewing some of the old decadent stands and keeping up the representation of Douglas fir in immature thrifty age classes.

There is another side of the story, however. Sometimes these prehistoric fires—whether set by Indians or Zeus—came too frequently or covered too big an area for natural reseeding, or were not followed soon enough by a seed crop, with the result that instead of a heritage of normally well-stocked stands the first white men found many unproductive old burns, brush fields and thinly stocked stands.

But in spite of lightning bolts and the incendiarism of the Indians we must conclude that the forest was holding its own over the region at large through the prehistoric centuries. The natural reproductive power of the native tree species, aided by the favorable climate, offset the destructive agencies that were at work.

This natural balance was, however, rudely upset when the axe was added to the destructive agencies. About 75 years ago lumbering began in this region, at first on a very small scale, but rapidly accelerating in the last thirty years. Now approximately 250,000 acres are logged each year in western Oregon and western Washington. Ninety-five per cent. of this is on private lands where, except in a few isolated cases, there is no conscious effort made to promote the regeneration of the forest. The remaining 5 per cent. of the logging is mostly on national forests where provision is made at some expense to assist nature in the reforestation of the cut-over area.

The method of logging necessitated by the large trees and dense stands, and almost universally employed, is to cut absolutely clear and remove the logs by power machinery. Following the logging the débris-covered area is burned broadcast, effectually killing all vegetation at least to the ground. The area is then left black and barren, without seed trees, without saplings and often without humus. In any other forest region where the trees were not of sprouting species, such treatment would likely result in complete annihilation of the forest and its restoration only by the slow process of migration with perhaps intermediate stages of brush and temporary tree association. That some of the Douglas fir lands so clean cut and broadcast burned are regenerating naturally to Douglas fir is a tribute to the reproductive vigor of this species and to the favorable physical conditions of soil and climate and is economically very good luck.

Probably a half of the lands now being logged are not regenerating naturally to a real forest growth. This is a very serious situation in this region where forests are the only crop for three quarters of the land area and where the potentialities for timber production are so great. It becomes an ecological prob-

lem of the first magnitude to discover the factors which militate for and against the establishment of a new forest after the removal of the old.

I should like to mention briefly some of the ecological conditions, brought about by present logging practices, that influence the perpetuation of the forest. The facts that I shall give are taken largely from the research of the Pacific Northwest Forest Experiment Station, especially from the work done by Mr. L. A. Isaac, of this station.

The conditions I will picture are characteristic of the larger logging operations, where practically all living trees are cut down or knocked down by the logging and the area is burned broadcast and where the edge of the standing timber is pushed back a quarter of a mile to a mile a year, and where many square miles of continuous logged-off land accrue in a few years.

The sudden and complete removal of the dense Douglas fir forest creates a very radical change in the environmental conditions. It is so great a shock that many of the plants of the virgin forest can not survive in the open. It is only because Douglas fir seedlings are inured to adversity and do not need the nurse effect of a partial overwood that they return after forest conditions have been destroyed.

The environmental conditions that are radically altered are obvious. The insulation on the ground, which is about 5 per cent. under timber, is increased to 100 per cent. The average daily evaporation during the growing season as indicated by Livingston cup atmometers is 26 cc in the open as compared with 14 cc under the timber. During the same period the averge daily surface soil maximum temperature was found to be 80° F. in the timber and 131° F. in the open, and the average amount of moisture in the soil at a 3-inch depth was 19 per cent. under the timber, 13 per cent. in the open. Much of the humus is burned out of the soil. In steep country where soil is loose and exposure complete, erosion frequently follows; where active erosion is not noticeable there is often enough creep in the surface soil during periods of heavy rain to uproot tiny seedlings.

Seed supply is a prime consideration, for without seed it is obvious that there can be no new forest with species that do not sprout from the stump. The Douglas firs in the natural woods bear seed quite abundantly from early life to old age. A good crop for a large tree would be 50,000 seeds, and perhaps 10 times that amount might be borne on an acre. However, seed production in Douglas fir is periodic; some years there is no seed over large areas; at intervals of three to five years the crop is heavy. Two thirds of the time it is light. There has not been a heavy seed crop on Douglas fir over most of the region since 1923.

The seed is a popular food of birds, mice, chipmunks and insects, all of which destroy a prodigious amount of it. It has been found that when the cone crop is light a much higher percentage of the cones are infested with insects than when the cones are plentiful. Likewise it seems probable that in light seed years when the seeds are most needed for regeneration the rodents and birds that must subsist get a large proportion of it.

The relation of the animal life to the seed supply is very important and an intriguing field of research for a forest biologist. Birds and rodents are not abundant in the virgin forest, and the broadcast slash fire probably decimates their number for a while. But as the cut-over area grows up to weeds and brush it becomes a more hospitable habitat and the birds and rodents build up their population. There is some reason to believe that the older cut-over areas become progressively more difficult for reforestation because of the inroads of these predators upon the seed supply. Even if seed is produced within dissemination distance of the deforested area it has slim chances of surviving for germination, except in years of a bumper crop.

This brings us to the question of seed dissemination. It has puzzled foresters a great deal to know to what distances from the mother tree the seed is scattered, because it is so difficult to be sure of the point of origin of any seed or seedlings. Apparently wind is the sole important agency in the dissemination of Douglas fir seed; its effectiveness in wide dispersal has been underestimated by some and much overestimated by others. Recently systematic work has been done to arrive at the laws of seed flight, with rather interesting results. Seed was dropped from kites and recovered on the snow and the natural fall from seed trees was trapped through the season. It appears that most of the seed is dispersed early in the fall, but a little is held in the cones until spring, illustrating very nicely the old adage that nature doesn't put all her eggs in one basket.

Through the season 83 per cent. of the seed scattered in one direction by an isolated block of timber fell within 500 feet of the edge of this timber, and one seed was recovered at a distance of 2,400 feet. In an 8-mile wind seed released from a kite at 200 feet fell in greatest density 1,200 feet from the point of release, and the maximum distance that any fell was 2,000 feet. This is for level ground. With other wind intensities the distances were proportional. All this goes to prove that it is the exceptional seed that is carried more than a quarter of a mile on level ground. This is not denying that seeds are probably

carried by rising air currents, high winds or over crusted snow much greater distances, but natural reforestation can not be predicated on the unusual.

There is another seed supply factor that must be taken into account besides the seed that is disseminated following the cutting, namely, the seed that may have been cast by the virgin forest prior to cutting and that has remained viable through the logging and slash burning process. How potent this source of seed is still remains a question. It is hard to account for the abundant reproduction on some of the older burns where no living seed trees survive over thousands of acres, except on the theory that seed was stored in the duff ready to germinate when heat and light were admitted by the burning of the mature trees. However, a series of experimental seed storage tests indicates that very, very little Douglas fir seed remains viable in the forest floor more than one year. Hence we are forced to the conclusion that unless there has been a good seed fall within a year prior to the cutting, little Douglas fir reproduction can be expected from seed stored in the duff. Even then much of it must be killed by the slash burning, though there is always a chance for some of it to survive where stirred in the mineral soil by the logging or where the fire has skipped.

Let us suppose now that our logged-off area has been wind sown with seed from nearby uncut timber and considerable of it has escaped the ravages of insects, birds, rodents and fire, or that some viable seed cast by the old forest just before it was cut still remains in the ground. What factors control the germination of the seed and the successful establishment of the seedling? It is indeed a precarious birth that Douglas fir has, as it is with the beginnings of most forms of life.

It is obvious that many of the seeds falling in this débris-strewn, logged-off land fall where they have no chance at all to germinate. The spring climate is ordinarily excellent for germination—plenty of surface moisture at a time when the temperature is right to start growth.

But the tender seedling has many dangers to avoid if it is to survive. Let me cite a few of the causes of infant mortality in Douglas fir which experimental work has demonstrated. Prominent among the causes for loss in very young seedlings is superheated surface soil. The first hot days of early summer when the seedlings are still succulent and about 1½ inches high give a surface soil temperature (in one area studied intensively) of 150° F. with an air temperature of 95° F. Now Douglas firs of this age succumb with a characteristic heat lesion on the stem when the surface soil temperature reaches 120° to 145° F. Hence seedlings on exposed south slopes or those standing in the full sunlight, unprotected by the shade of weeds, shrubs or logs, can be expected to die in an early summer hot spell and they do. The fact that much of this logged and burned land is blackened with charcoal makes the surface temperature even more unfavorable. On one area there was a difference of 17° F. in the surface temperature of a charcoal darkened soil and an adjoining plot of natural yellow-brown soil. On the blackened soil all the seedlings died in the first hot wave (the soil was still moist) while only 32 per cent. of the seedlings died on the adjoining lighter colored soil.

Another cause of early mortality is drought, for this is a region with little or no rain in July and August. Douglas fir strikes its taproot down vigorously and reaches a length of about five inches when two months old, but this is not always enough to overcome the terrific desiccation of the surface soil to which these stripped, burned lands are subjected.

On the top of heat and drought comes some loss due to fungi resulting in damping off. This, however, is not as serious apparently with seedlings in their natural environment as with seedlings crowded in a nursery bed.

It was somewhat of a surprise to find recently the rather large rôle that mice play in the infant mortality of seedlings. In one experimental area mice grazed off the tops of newly germinated seedlings, accounting for a loss of 95 per cent. in two or three days. This is perhaps unusual and was on an area not burned for five years where the rodent population had had a chance to build up.

Supposing now that our Douglas fir seedlings have successfully run the gamut of heat, drought, parasitic diseases and animal predators, they next come into very direct competition above and below ground with other native vegetation. For these logged and burned areas, black and barren as they are, become clothed surprisingly soon after slash burning with a luxuriant and varied assortment of weeds and shrubs, some of which are the residue from the flora of the virgin woods, like vine maple, Oregon grape and salal, and some have seeded in from afar like fireweed, hawkweed and senecio. This associated vegetation plays the dual rôle of nurse and executioner. It offers beneficial shade to the very young seedling, hence germination and early survival is much better on the north side of clumps of bushes than on the south.

But Douglas fir after a few weeks becomes very demanding of light, and plants that have much shade do not thrive. The character and density of the weed and shrub vegetation are of immense importance to the survival of the Douglas fir seedlings. This vegetation varies from area to area and changes from year to year in a most interesting ecological succession not

perfectly understood. If the area has never been burned following logging the composition of the flora is very different from that on burned areas and is more stable. By and large each year after logging the cover becomes denser, so that in a 10-year cutting the ground is matted with dried vegetation and in midsummer the weeds and shrubs often make a head-high jungle where open spots are few and far between. In such an area seed has little chance to find a germinating bed or tiny seedlings to survive the competition of a continuous cover of six-foot plants. It may be concluded that when the natural vegetation is dense from about the third year after logging the establishment of seedlings becomes more and more difficult. Areas therefore which are not seeded rather soon after cutting have a diminishing chance of ever becoming restocked with Douglas fir, even with a constant seed supply. This would not be true of poor soils where the herbage was sparse or on exposed slopes where the secondary plants help rather than obstruct the Douglas firs.

When the trees get a head start on the weeds and shrubs or are able to find plenty of light in spite of this competition, they make vigorous growth and after the first three years begin to shoot up at the rate of a foot, then a foot and a half and even two feet a year, so that by eight or ten years they are past the danger of being smothered by lack of light. Then the Douglas firs come into competition with each other, which is another story.

The young Douglas fir forest after it is abreast of the weeds and brush is a very thrifty crop, singularly free of pests and vigorous in its production of useful wood fiber. The owner of such an established stand of saplings can begin to count the profits such a new forest will yield 30, 40 or 50 years hence—except for one thing, the constant hazard of fire. The great danger of fire is an ever-present accompaniment of the transition from old forests to new. It has been estimated that the fire hazard on cut-over land is 25 times as acute as in virgin Douglas fir forests. The peak is reached when the fresh slash still litters the ground. Broadcast burning consumes only a part of the mass of logging débris, and the weeds and bushes soon add their annual contribution of tinder. It takes but a spark in midsummer to reburn the whole area, Douglas fir seedlings and all. At present quite a percentage of the cut-over lands of the region are reburned annually. After each fire the process of natural regeneration of the area becomes more difficult, especially because of the decreased chances of a seed supply in the vicinity.

Only when the trees have grown large enough to shade out the annual weeds and to make a solid canopy that will keep the ground moist does the fire hazard diminish and begin to equal that of the old-growth forest. The character of the low vegetation that follows logging has much to do with the fire hazard, whether it be fireweed, bracken fern, deciduous bushes, etc. Perhaps it may be found that by modifying the methods of disposing of the slashings or by other treatment of the area, such as the grazing of livestock, the character of this vegetation can be modified to lessen the fire danger during this critical period in the inception of the new forest.

This recital of the ecological factors that bear upon the reestablishment of the Douglas fir forest after logging and fires would be incomplete unless I pointed the moral of the story. It is this. Man's industry in converting the forest into useful products is having a cataclysmic effect on land productivity. Present logging methods practically annihilate every vestige of the old forest and make it very difficult for a new one to become established. Man's ingenuity must now be employed to devise ways of logging and of fire control that will ameliorate the inevitable destructive operation of timber harvesting and help a new forest to come back in the ashes of the old. I speak, of course, only of those lands which are not adapted and not needed for agricultural crops—lands whose highest use for the present is production of forest crops. It is very roughly estimated that from 80 to 90 per cent. of the Douglas fir lands now being logged are of this category, and unless reforested they will lie idle and unproductive.

The technique of making conditions possible for the natural regeneration of this aggressive pioneering species, Douglas fir, in this favorable climate is not difficult or impracticable. It entails first of all seeing to it that there is an adequate source of seed, especially by organizing the cutting so that each block of cut-over land can reseed from adjoining timber, or by leaving single seed trees of low commercial value. Sometimes artificial planting of nursery-grown trees may be the cheapest and surest procedure.

A further important step, which the preceding discussion of ecological factors has suggested, is discrimination in the slash burning so that areas of extreme exposure or those that are already sprinkled with seed or seedlings may be spared from destructive burning, unless this operation is essential to safety from fire and really lowers the inflammability over a term of years.

The exclusion of fires from areas already slash burned or already reproducing is essential, and here there are preventive measures which if assiduously performed will help greatly to control the fire menace. Time does not permit detailing the several operations which could be performed to make conditions better and safer for reforestation.

The subject assigned to me was obviously limited to the biological aspects of forest renewal, and I have discussed the reforestation problem only from that angle. There is another phase of this subject which I can not wholly pass by—the economics of reforestation under private ownership. The lumber industry of the Douglas fir region is operating under obstacles of overproduction, cut-throat competition in distant markets, the menace of fires from the operation itself as well as from sources beyond the control of the owner, and heavy carrying charges, particularly a system of taxation that taxes both the land and the value of the timber upon the land each year. In the face of these obstacles there is an urge to liquidate the capital investment; there is little interest in holding the land for continuous production, and an unwillingness to spend even a small amount to leave the land in productive condition. The silvicultural measures that would promote reforestation, the desirability of which are recognized by all, are not likely to be adopted except by the few strong and far-seeing companies until these economic obstacles are removed. It is the responsibility of the public to rectify the tax situation and eliminate the outside fire menace, as it is of the industry to remove the other obstacles; happily each year sees progress in this regard, but it is slow. The transition from old forests to new is too often a transition from old forests to worthless, blackened stump land whose return to a cover of useful trees will be a slow or expensive process.

OBITUARY

RECENT DEATHS

PROFESSOR WILLIAM DILLER MATTHEW, chairman of the department of paleontology of the University of California, died on September 24 at the age of fifty-nine years.

DR. NATHANIEL O. HOWARD, pathologist of the Department of Agriculture, stationed at Brown University and instructor in botany at the university, died on September 14 at the age of fifty years.

DR. ROSS HALL SKILLERN, well-known laryngologist and professor of laryngology in the graduate school of medicine of the University of Pennsylvania since 1918, died on September 20. He was fifty-four years old.

FREDERIC M. STROUSE, assistant professor of laryngology in the graduate school of medicine of the University of Pennsylvania, died on August 4 at the age of sixty-six years.

BROTHER AZARIAS MICHAEL, dean of the engineering school of Manhattan College, died on September 17 at the age of fifty-three years.

DR. MURRETT F. DE LORME, head of the Lindsay Laboratories, Inc., in Brooklyn, which he founded twenty years ago, and professor of clinical medicine at the Long Island Medical College, died on September 8, aged sixty-two years.

DR. ALONZO ROUSE KIEFFER, formerly professor of surgery and head of the department of clinics at the Barnes Medical College, died on August 13 in his seventy-fifth year.

MAJOR GENERAL SIR NEVILLE HOWSE, V. C., who was a medical officer in the Australian army and who was one of Australia's representatives at the fourth assembly of the League of Nations, has died at the age of sixty-seven years. He was a fellow of the Royal College of Surgery.

PROFESSOR H. B. DIXON, of Manchester University, England, regarded as one of the world's foremost experts on explosives, ex-president of the British Chemical Society and holder of the Royal Medal of the Royal Society, died on September 18 at the age of seventy-eight years.

MEMORIALS

A MEMORIAL to George Westinghouse, inventor and founder of the various Westinghouse industrial enterprises, will be dedicated in Pittsburgh on October 6, according to an announcement by A. L. Humphrey, chairman of the Westinghouse Memorial trustees. Leaders in industry, science and education have been invited to pay tribute on that day to the memory of the inventor of the airbrake and the steam turbine and the proponent of the alternating current. The ceremony will include the unveiling of a bronze statue by Daniel Chester French. The main unit of the memorial rises twenty feet from a Norwegian granite base and includes a dominating figure of the subject, in the prime of life. Beside him are two figures depicting a skilled workman and an engineer, typical of the thousands of artisans who assisted him during his life. Facing this group on a separate pedestal is a figure of an American youth studying the achievements made.

A MEMORIAL to Carl Ben Eielson, who lost his life in the Arctic regions last November while engaged in the work of bringing passengers and cargo by plane from the icebound steamer *Nanuk*, will be erected at the Alaska Agricultural School and College of Mines. The memorial will be a building for the Fairbanks school, which will house the "Colonel Carl Ben Eielson School of Aeronautical Engineering." It is expected that $15,000 to $25,000 will be raised at Fairbanks, toward which $4,000 has already been subscribed.

SCIENTIFIC EVENTS

THE WHIPSNADE ZOOLOGICAL GARDEN

SIR PETER CHALMERS MITCHELL, secretary of the Zoological Society, London, in an address to members of the Luton Rotary Club, said, according to the London *Times*, that he hoped the new Zoological Garden at Whipsnade would be open next spring. Sir Peter stated that

The London zoo was becoming too small because of the increasing number of visitors, and because if they were going to keep animals in captivity they should give them the maximum amount of freedom and open air. In London they tried to keep a large number requiring heat and indoor accommodation, and thus they had to provide a large number of buildings of that kind, so that they came to the conclusion that they ought to have an extension of the grounds, which was impossible in London.

Whipsnade was, in his mind, an intermediate stage, a link in a much bigger scheme. Personally, he believed it was the duty of the present generation all over the world to preserve the existing animals of the world so far as it was possible. There were three ways of doing that. They had the intensive way, like the zoo in London. The next thing was what they hoped Whipsnade was going to become—a place where the animals would be able to be shown far more in their natural conditions. The third stage was that there ought to be in every part of the Empire great open-air reserves where animals would be allowed to remain absolutely in their natural freedom.

His image of the future of these national parks and reserves in Africa, India and so on was not that the animals should be enclosed, but that, if necessary, the visitors should be enclosed, that there should be covered ways going through these reserves where people could see the animals absolutely free and in their natural conditions.

It had been said that Whipsnade was merely to be a sort of sanitary station, to which they were to send sick animals from London. It was to be nothing of the kind. What they did think was that at Whipsnade they would be able to give animals much more space and freedom, and that there would be a larger number of animals breeding down there, and that they would keep in London only selected animals in the pink of condition. There would be a constant exchange between the zoo at Whipsnade and the zoo in London. The new zoo would be as free to the public as to the fellows of the society, and would be open on Sundays on payment, just as on week days, and for that reason they were laying it out on the scale which would hold crowds. The maximum comfortable capacity at the London zoo was 20,000, but from the way the Whipsnade zoo was laid out it should be able comfortably to hold 100,000, and to provide for that they were having five restaurants, scattered in different parts of the park. Round about each of these places would be land that could be used for picnics.

In relation to the animals, they were trying to arrange them in a series of large paddocks, with places for the public along the front of the paddocks, which would be completely surrounded in time by trees. There would be open paddocks with a background of trees, behind which they were going to make huts, cages and dens for the animals. These would be entirely concealed from the public by trees. It would be possible, with electric power from Luton, to provide them with heaters, which could be switched on from some central point when the weather made it necessary. He could not tell them exactly all the animals they were going to begin with at Whipsnade. They had already a certain number of bears, some cranes, and several kinds of deer, which had been breeding very well. They hoped in the course of this winter to make provision for elephants, camels, lions, tigers and wolves, with a great many kinds of antelope and deer. They had already a small herd of bison, and were going to have a herd of white marked cattle, given by the Duke of Bedford. There would also be many different kinds of birds. By next Whitsuntide the zoo would not be anything like completely ready, but they hoped there would be enough to interest the public.

THE NATIONAL ARBORETUM

A TRACT has been selected near the Anacostia River above Benning Bridge on Mount Hamilton for a national arboretum, which will be an educational and recreational center near the capital. The Congress has authorized an appropriation of $300,000 to develop the project.

The arboretum, according to a report in the Baltimore *Sun*, will cover about 800 acres. Half of the needed area is already owned by the government in a stretch of marsh lands along the Anacostia River. Adjoining this are about 400 acres of wooded highland known as the Mount Hamilton and Hickory Hill tracts. The two pieces of land afford an admirable diversity of physiography and soils needed for many types of plants.

The chief purpose of the national arboretum will be to promote scientific research and diffusion of knowledge of plants, as well as to establish a garden for the permanent preservation of the authentic living specimens of the thousands of plants which the Department of Agriculture has introduced from foreign countries.

It will be a plant museum, wherein the cultivated plants and their wild relatives, growing together in the same climate, may be studied as source material for the breeding of the more valuable species. It will afford botanists an opportunity to carry on research which will be of great assistance to the U. S. Department of Agriculture in developing the strongest types of plants of superior qualities. Plants and trees that

resist certain diseases will be studied with the object of replacing the types which are easily infected with destructive blights. Search has been made in the Orient in the hope of finding trees sufficiently resistant and of the necessary size to take the place of the chestnut. At a saving of time and effort and at much less expense it is proposed to breed a disease-resisting chestnut from the material that exists in this country or which may be easily obtained. There is a similar need for the development of other types of pest-resistant trees and plants.

The vicinity of Washington is said to offer one of the best regions in the country for growing plants and trees that belong to both warm and cold climates.

THE FIRST TRANSCONTINENTAL FRUIT TRANSPORTATION LABORATORY

THE Chicago Great Western Railroad brought into Chicago on September 23 the first transcontinental fruit transportation laboratory. The laboratory, which consists of a fifty-two car train of citrus fruits, destined for Chicago, New York and other eastern points, left Colton, California, at 9:30 A. M. on September 16, reaching Chicago in 146 hours. The Great Western Railway received it from the Union Pacific at Council Bluffs on the following Monday.

Riding with the train in a special car were four ventilation and temperature experts of the U. S. Department of Agriculture, C. W. Mann, W. C. Cooper, R. J. Asbury and J. G. Gray, and four representatives of the Pacific Fruit Express Company. *En route* they made continual tests and recorded the efficiency of refrigeration and ventilation equipment. Accurate control of these factors is of primary importance in the long-distance shipping of all perishables, and it is anticipated that the series of tests on this trip will yield results important to shippers of food products.

At Council Bluffs, R. B. Croll, superintendent of transportation for the Great Western Railway, and division superintendents, S. V. Rowland and C. J. Kavanagh, conducted the party over their respective divisions. Including a re-icing stop at Oelwein, Iowa, this part of the journey took approximately 24 hours.

A part of the trainload went to the Chicago market for Middle West consumers and the rest was delivered by the Great Western to the Erie for transportation to the East.

The 146-hour schedule on which the laboratory train moved from California to Chicago is the regular schedule for perishable freight. Its time is exceeded only by the fast silk trains which carry oriental silks from Pacific ports to the East. But, whereas silk moves in four to twelve car trains, using express and passenger equipment, perishables move in forty to fifty car trains, using regular freight equipment, and numerous stops must be made for re-icing cars.

Colton, California, which serves the southern part of the state, is one of the three principal concentration points from which western citrus fruits move into the eastern markets. The Great Western, according to Oscar Townsend, vice-president in charge of traffic, handles a large volume of this and other perishable freight on fast schedules, and it has a record of over a year's standing of 100 per cent. on time arrivals of trains of perishables.

COURSE IN THE RADIOLOGICAL DIAGNOSIS OF CANCER

MORE than 300 X-ray experts from all parts of the United States and Canada assembled at Baltimore on September 10 for a three-day post-graduate course designed to improve radiological diagnosis of cancer and to make known the latest discoveries. The meetings were arranged under the auspices of the Chemical Foundation, of which Mr. Francis P. Garvan, of New York, is president, and the Bloodgood Cancer Research Fund, whose director, Dr. Joseph Colt Bloodgood, presided. The courses were held morning, afternoon and evening daily in the Belvedere Hotel.

All sessions were confined to diagnosis and treatment of tumors and bone diseases and approximately ninety cases were studied. Dr. Joseph S. Ames, president of the Johns Hopkins University, and Dr. John M. T. Finney, professor of clinical surgery at the School of Medicine, were both speakers on post-graduate teaching in medicine. Dr. William S. Baer, professor of orthopedics at the Johns Hopkins University, spoke on the diagnosis and treatment of osteomyelitis and described his method of treatment with live maggots. Other speakers included Dr. William B. Coley, of Memorial Hospital, New York, and Dr. Harvey Smith, chief surgeon, Harrisburg, Pennsylvania, Hospital. Dr. John Shelton Horsley, of Richmond, Virginia, discussed recurrent giant cell tumors. The new Radiological Research Institute's program of activities was described by Dr. Edwin Ernst, president of the Radiological Society of North America. Dr. Hugh H. Young, professor of urology, the Johns Hopkins University, discussed the relations between bone diseases and cancer of the prostate; Dr. Henry Jaffe, orthopedic surgeon at the Hospital for Ruptured and Crippled Children, New York, spoke on experimental osteitis fibrosa in hyperparathyroid animals. Dr. Frederic J. Cotton, chief orthopedic surgeon, Boston City Hospital, discussed the relation of fractures and injuries to bone tumors.

Foundations were laid for the establishment of a correspondence course in cancer diagnosis, planned to

keep pathologists, physicians and surgeons, living far from the great centers, in touch with the experiments and discoveries of the surgical pathological laboratory of the Johns Hopkins University, where the records of thousands of cancer cases are filed. The primary object of the course is to increase the accuracy of early diagnoses of cases which may or may not be cancer and thereby improve the chances of the patient's recovery and avoid unnecessary amputations. It is also designed to develop improved methods for post-graduate instruction in special diagnosis of special diseases. Sections of tumors from the collection at the Johns Hopkins University will be mailed to students with case histories of the disease. The student will return them with his diagnosis, which will then be corrected in the light of the laboratory's further experience, and returned with explanations to the student, who will thus have an opportunity to study cases which would otherwise be denied him by his geographical location. As at present planned, the course would be open only to professional men and women who have attended clinics at the university.

Dr. Bloodgood, who will conduct the course, will have the assistance of the surgical pathological laboratory's staff, including Drs. George A. Stewart, L. Clarence Cohn, Charles F. Geschickter, Max Kahn, Murray M. Copeland, E. S. Anderson and R. L. Oliver; Messrs. G. T. Thompson, R. F. C. Kegel and R. C. Major, special students of the Garvan Research Fund; Dr. L. Bonelli, resident surgeon, St. Agnes' Hospital; Dr. J. R. Moore, special graduate student in the laboratory and chief orthopedic surgeon, Shriners' Hospital, Philadelphia.

INTERNATIONAL HIGHWAY ENGINEERS' TOURS

THREE hundred invitations have been issued to official and other delegates to the Sixth International Road Congress to participate in the highway inspection tours sponsored by the Highway Education Board, following the sessions of the congress from October 6 to 11. These invitations have gone to prominent highway engineers and administrative officials of more than sixty countries.

The Highway Education Board, with headquarters at 1723 N Street, Washington, is sponsoring the tours. The chairman of the board is Mr. Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, and on the board are the following members: Dean F. L. Bishop, Society for the Promotion of Engineering Education; Wilbur J. Carr, Assistant Secretary of State; Roy D. Chapin, National Automobile Chamber of Commerce; J. Walter Drake, former Assistant Secretary of Commerce; Pyke Johnson, National Automobile Chamber of Commerce; Fred I. Kent, American Bankers' Association; H. H. Rice, National Automobile Chamber of Commerce; L. S. Rowe, Director General, Pan American Union; W. O. Rutherford, Rubber Manufacturers Association, Inc.; F. A. Seiberling, Rubber Manufacturers Association, Inc.

The tours have been arranged to afford the delegates participating an opportunity to acquire first-hand information on the construction, maintenance and use of all types of modern highways in the United States. In so far as time permits agricultural and industrial activity along the routes of the tours will be studied, with particular reference to the relationship to highway transportation. The delegates invited to participate will be divided into groups of the same size for each tour.

The first tour will be devoted to a study of high-type, heavy traffic roads in densely populated industrial areas, including metropolitan area developments. The second will include a thorough study of all types of roads, principally in agricultural areas and in temperate and semi-tropical zones. Special attention will be given to the utilization of low-cost roads in the semi-tropical part of the country. The third will be devoted to all types of roads under varying topographical and climatic conditions, with particular reference to winter conditions of frost and snow and low-cost roads in northern latitudes.

Among the national groups cooperating with the board are the American Association of State Highway Officials, the American Automobile Association, the American Petroleum Institute, the American Road Builders' Association, the U. S. Chamber of Commerce, Motor and Equipment Association, the Rubber Association of America and the National Automobile Chamber of Commerce.

State highway departments are laying out and marking tour routes, staging special construction and maintenance exhibits and otherwise cooperating fully to make the tour a thorough survey of American highways and highway transport. Chambers of commerce and other local groups will entertain the delegates *en tour,* and railroad and bus lines are cooperating with arrangements for the transportation of delegates.

The Departments of State, Agriculture and Commerce and the Pan American Union are cooperating with the Highway Education Board. It is anticipated that many of the experts of the commodity divisions of the Department of Commerce, as well as officials of the Departments of State and Agriculture and several American consuls and commercial attachés at important points throughout the world who are visiting the United States will accompany the party.

SCIENTIFIC NOTES AND NEWS

DR. HEBER D. CURTIS, director of the Allegheny Observatory, has been appointed director of the new observatory and head of the department of astronomy of the University of Michigan, and will assume his new duties on October 15. Dr. Frank C. Jordan, who has been a member of the staff of the Allegheny Observatory since 1908, first as astronomer and later as assistant director, has been appointed director of the Allegheny Observatory, and Dr. Keivin Burns has been appointed assistant director.

DR. HENRY FAIRFIELD OSBORN, president of the American Museum of Natural History, has been awarded the Daniel Giraud Elliot Medal for 1929 by the National Academy of Sciences for his monograph on Titanotheres.

BY vote of the Grasselli Medal Committee of the American Section of the Society of Chemical Industry the Grasselli Medal for 1930 will be awarded to Per K. Frolich for his work on synthesis under high pressure. The presentation of the medal will be made at a joint meeting of the Chemical Societies in New York on November 7. At that time Professor W. K. Lewis will speak on the accomplishments of the medalist. Due to alterations being made at The Chemists' Club it is planned to hold the meeting at Columbia University.

HONORARY degrees will be conferred by the University of Pennsylvania on eight prominent medical men on October 10, in connection with the one hundred and sixty-fifth anniversary of the founding of the school of medicine of the university. Dr. William H. Welch, of the Johns Hopkins University, will receive the degree of doctor of literature. Surgeon General Hugh S. Cumming, of the United States Public Health Service; Dr. J. Ramsay Hunt, of Columbia University; Dr. Alonzo E. Taylor, of Stanford University, and Professor A. V. Hill, University College, London, will receive the degree of doctor of science. Sir Walter Fletcher, secretary of the Research Council of Great Britain; Dr. William Gerry Morgan, president of the American Medical Association, and Dr. Alfred Stengel, of the University of Pennsylvania, will receive the degree of doctor of laws.

PROFESSOR ELIHU THOMSON, director of the Thomson Research Laboratory of the General Electric Company, was given on September 27 a dinner by business and professional organizations represented in the Allied Service Council of Greater Lynn. The principal address was made by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology.

UPON the advice of his physicians President James Rowland Angell, of Yale University, who underwent a serious operation during the summer, will not resume his active work at Yale University until about the tenth of October. President Angell was able to leave the hospital late in August and has been making a satisfactory convalescence. He will resume his full regular duties when he returns to Yale in October.

APPOINTMENTS to the faculty of Columbia University have been announced as follows: Professor Joseph W. Barker, formerly head of the department of engineering at Lehigh University, succeeds Dr. George B. Pegram as dean of the school of engineering; Professor Frank Lewis Eidmann, of Princeton University, becomes professor of mechanical engineering, and Professor George B. Karelitz, of the Westinghouse Electric and Manufacturing Company, becomes associate professor; Dr. Karl M. Dallenbach, of Cornell University, becomes visiting professor of psychology; Dr. Franz Schrader, of Bryn Mawr College, becomes professor of zoology, and Dr. Elmer Drew Merrill, present director of the New York Botanical Garden, becomes professor of botany. Dr. Crawford F. Failey, of the Johns Hopkins University, and Walter F. Sperry, of New York, have been appointed assistant professors in biological chemistry; Professor Rustin McIntosh, of the Johns Hopkins Hospital, will be professor in diseases of children; Dr. George W. Bachman, of the School of Tropical Medicine, San Juan, Porto Rico, becomes associate professor in parasitology; Dr. Samuel T. Orton, of the University of Iowa, has been named professor in neurology and neuropathology; Bert George Anderson and Bror Eric Dahlgren will be associate professors of dentistry.

AT Harvard University Karl Menger, associate professor of mathematics at the University of Vienna, and Jan Arnoldus Schouten, professor in the Technische Hoogeschool of Delft, are visiting professors of mathematics; Oliver D. Kellogg has been made professor of mathematics; Alfred C. Redfield is professor of physiology; Shields Warren is instructor in pathology; Constantin P. Yaglou is assistant professor of ventilation and illumination; Earl C. Cummings is assistant professor of roentgenology; Truman L. Kelley, formerly of Stanford University, has become professor of education and psychology.

DR. HOWARD J. SHAUGHNESSY, an instructor in the University of Chicago, in charge of research investigation on infantile paralysis, has been appointed chief of diagnostic and research laboratories of the state

department of public health of Illinois, to succeed Dr. Thomas G. Hull.

Professor John C. Slater, associate professor of physics at Harvard University, has become head of the department of physics at the Massachusetts Institute of Technology.

Professor S. C. Hollister has been appointed to head the structural engineering department of the school of civil engineering of Purdue University. Professor Hollister succeeds Professor E. L. Eriksen, who was recently appointed to the chair of engineering mechanics at the University of Michigan.

Dr. Rolland J. Main, formerly of the department of animal biology of the University of Oregon, has become associate in physiology and pharmacology at the Medical College of Virginia.

Dr. H. D. Squires has resigned his position as instructor in the department of geology of Ohio State University, to accept a position as assistant professor at the School of Mines of Oregon State Agricultural College.

Nathan C. Clark, formerly connected with the Telephone Laboratories, Inc., of San Francisco, and special technical adviser for the U. S. Forest Service, has been appointed instructor in electrical engineering in the college of engineering of the University of Southern California.

Frank E. Chapman, director of Mount Sinai Hospital since 1915, has been appointed to succeed Dr. Karl H. Van Norman as director of the Western Reserve University hospital group, which includes Lakeside, Babies and Maternity Hospitals.

R. C. Wells has been appointed chief chemist in charge of the division of chemistry and physics, geologic branch, U. S. Geological Survey, and George Steiger, former chief, will return to studies in chemical and spectroscopic analysis.

Dr. Ralph B. Kennard, until recently head of the department of physics at Robert College, Constantinople, has been appointed research associate at the U. S. Bureau of Standards, where he will work on problems involved in the transfer of heat by convection.

Professor Manley Champlin, senior professor of field husbandry, University of Saskatchewan, Saskatoon, left recently for Berkeley, California, where he will spend a year in special work at the University of California.

Dr. Percy T. Watson has responded to the plea of Chinese authorities to return to China to fight an outbreak of the bubonic plague. He will leave in about three weeks for Shensi and Shansi Provinces of Northern China.

Baron Chuzaburo Shiba, director of the Japanese Aeronautical Research Laboratory, vice-president of the World Engineering Congress in Tokio and member of the House of Peers, was greeted by his American and Canadian friends upon his return from attendance at the World Power Conference in Berlin. He was met at Quebec by two Canadian engineers who accompanied him to New York. He was the guest of honor there at a dinner at the Lotus Club, September 22, given by Mr. Tijima, and a luncheon at the Engineers Club given by the Engineering Societies the next day. He left that afternoon for a brief visit to Washington and to Langley Field and expected to sail for Japan from Vancouver on October 2.

Dr. Franz Knoop, professor of physiological chemistry and director of the institute for physiological chemistry, University of Tübingen, will give two lectures on "Intermediary Metabolism" under the Edward K. Dunham Lectureship for the promotion of the medical sciences at Harvard Medical School on October 15 and 17 at 5 P. M.

Dr. Hans Zinsser will deliver the Carpenter Lecture before the New York Academy of Medicine on October 29. His subject will be "Immunity, General and Local."

Dr. A. V. Hill, Foulerton professor of the Royal Society, will give the Eldridge R. Johnson Foundation Lectures at the University of Pennsylvania for 1930. The series will include four lectures on "Adventures in Biophysics" on the following dates: October 13, "Some Adventures with Vapor Pressure"; October 14, "The State of Water in Tissues"; October 15, "The Conception of the Steady State"; October 16, "Certainties and Uncertainties in Muscle." These lectures will follow the celebration of medical progress at the university in connection with which Professor Hill will give an address on "The Physical Reasonableness of Life."

Official delegates from the nations of North and South America and representatives of a number of private organizations took part at the Pan American Union of the first Inter-American Conference on Agriculture, Forestry and Animal Industry which was held from September 8 to 20 in Washington. The conference was arranged to define the outstanding problems in each country which may be solved by inter-American cooperation; to discuss policies and methods to be followed in the cooperative solution of these problems, and to consider the establishment and location of research stations or laboratories. The del-

egates were received by President Hoover. Henry L. Stimson, Secretary of State; Arthur M. Hyde, Secretary of Agriculture; Robert P. Lamont, Secretary of Commerce, and Dr. George K. Burgess, chief of the Bureau of Standards, were on the program of addresses.

EIGHT university and college presidents are among the large number of leaders in agricultural education and research who already have accepted invitations to attend the fiftieth anniversary celebration of the New Jersey Agricultural Experiment Station on October 8 and 9. They are Livingston Farrand, Cornell University; Bradford Knapp, Alabama Polytechnic Institute; Raymond A. Pearson, University of Maryland; R. W. Thatcher, Massachusetts Agricultural College; E. C. Brooks, North Carolina State College of Agriculture; F. D. Bluford, Agricultural and Technical College of N. C.; W. J. Hale, Tennessee Agricultural and Industrial State Teachers College, and Julian A. Burruss, Virginia Polytechnic Institute. In addition sixteen state agricultural colleges and experiment stations already have indicated that they will send delegates. Administrative officers from the United States Department of Agriculture who have sent acceptances include M. S. Eisenhower, director of information: Dr. J. R. Mohler, chief, Bureau of Animal Industry; Dr. Henry C. Knight, chief, Bureau of Chemistry and Soils; Dr. J. W. T. Duvel, chief, grain futures administration; Dr. Nils A. Olsen, chief, Bureau of Agricultural Economics, and Dr. O. E. Reed, chief, Bureau of Dairy Industry.

ACCORDING to the *Journal* of the American Medical Association the American College of Surgeons will hold its twentieth annual clinical congress in Philadelphia, October 13–17, at the Bellevue-Stratford Hotel. Demonstrations are to be given among others by Drs. John B. Deaver, Robert Shoemaker III, John Chalmers Da Costa, Thomas C. Stellwagen, P. Brooke Bland and Chevalier Jackson, all of Philadelphia. The address of the retiring president will be given by Major-General Merritte W. Ireland, Washington, D. C., and the address of the new president by Dr. C. Jeff Miller, New Orleans. The John B. Murphy oration in surgery will be given by Professor George Grey Turner, Newcastle-on-Tyne, England. Among the foreign guests will be Dr. William Ernest Miles, London, who will talk on "Cancer of the Rectum"; Professor Otfried Foerster, University of Breslau, Germany, surgical treatment of neurogenic contractures, and Professor Emile de Grosz, Budapest, Hungary, ophthalmologic surgery.

APPROPRIATIONS amounting to $6,500,000 for the enlargement of the U. S. National Museum were authorized by Congress at the session recently terminated. According to *The Museum News*, preliminary plans call for the extension of the present building on the east and west ends by the erection of additional courts. With these additions the building would extend from Ninth to Twelfth Streets and would contain approximately double the present floor space. The plan would duplicate the arrangement of the present building in that the ground floor and the fourth floor of each of the extensions would be given up to laboratories and study collections and the two intermediate floors to public exhibition halls. It is expected that work on the erection of the additions will be undertaken during the fiscal year beginning July 1, 1931.

FACILITIES for scientific research will be afforded astronomers of all nations by an observatory on the Jungfraujoch, Switzerland, at an altitude of 11,385 feet, which will open in the spring of 1931. Contributions from one of the Rockefeller Foundations, New York, the Swiss Natural Science Society, the Kaiser Wilhelm Society of Berlin, the University of Paris, the Royal Society of London and the University of Vienna made possible the creation of an international foundation to organize and control the observatory.

THE government of Spain announced on September 18 that a building donated by the Rockefeller Foundation for an institute of physical and chemical research has been completed at Madrid. The Rockefeller Foundation donated $400,000 for the purpose. The Spanish government will support the institution.

THE new college building of the Woman's Medical College of Pennsylvania was formerly opened on Wednesday afternoon, September 24. Dr. Donald Guthrie, fellow of the Surgical Research Society and member of the International Surgical Association, made an address on "The Modern Medical Graduate —Ambassador of Health." Addresses were made by Mrs. James Starr, president of the college, and Dr. Martha Tracy, dean. The building was built at an expenditure of $1,000,000.

THE $1,500,000 building of the Temple University School of Medicine was opened for the use of students when the autumn term began on September 24. It will not be formally dedicated until October 15, when Dr. William J. Mayo, chief of staff of the famous Mayo clinic at Rochester, Minnesota, will be the principal speaker.

THE new Conference Hall added to the Science Museum, South Kensington, England, is now almost completed, and the Office of Works hopes to hand it over in about a month's time for the inauguration of scientific lectures this winter. Unlike most of the public museums, the Science Museum has for some years pro-

moted public lectures in a small demonstration room in preference to lectures in the galleries by peripatetic guides. Lectures in the galleries are considered to be made largely unnecessary by the fullness of labelling devoted to exhibits, and the sedentary lectures are found to attract roughly three times as many listeners as the tours still made by staff lecturers.

PROFESSOR WILLIAM H. HOBBS, director of the University of Michigan Greenland Expeditions, has received radiograms which report that the two parties comprising the fourth expedition have each reached their respective stations in Greenland and have begun regular aerological observations. The northern party, under William S. Carlson, reached Upernivik in latitude 73° 45″ on August 21 and was setting up its base on the east side of an island (Angpilagtok), only fourteen miles outside the margin of the inland-ice and about the same distance northeastward from Upernivik. The southern party, under Evans S. Schmeling, reached Ivigtut in latitude 51° on August 27 and was ready to start regular aerological observations at that settlement on September 1.

WE learn from the New York *Times* that three members of the party under J. M. Scott which set out to establish a meteorological station on the highest part of the ice cap between their base and the west coast of Greenland returned recently after a very successful journey. The party consisted of Scott, John Rymill, Bingham, Quintin Riley and Martin Lindsay. Riley and Lindsay were left at the newly established station and will remain there two months. They will then be relieved by two more men. Scott was the only one of the party who had ever sledged or used dogs, yet taking very heavy loads to establish the station the party averaged eleven to twelve miles daily going in and thirty-eight miles daily coming out.

AT a recent meeting in Simla of the Governing Body of the Imperial Council of Agricultural Research, which was established under the scheme of the Royal Commission on Indian Agriculture, the council voted grants for improving sugar cultivation in the sugar belt running under the mountains from the Central Punjab to Bengal. Improved canes, introduced as the result of the development of special varieties, increase by 15 per cent. the yield of sugar from the cane crushed, and, with improved methods of cultivation, give the cultivator an increase of over 300 per cent. in the yield per acre. The council has also begun a scheme for the amalgamation and reorganization of rice research in the six Provinces of Burma, Bihar, Bengal, Assam, Central Provinces and Madras, which contain 75 per cent. of the 80,000,000 acres under rice and yield 33,000,000 tons of rice in a good year. Among other activities the council is establishing scientific committees to study the development of Indian oil seed crushing and the utilization of mechanical cultivation. In view of the heavy expenditure, totaling 10 lakhs of rupees (£75,000), on which the Punjab and the United Provinces were compelled to embark between February and May of this year, for the destruction of locusts, the council made a grant for an entomological investigation of the locust problem. It endorsed an arrangement by which two research workers of the University of Calcutta should devote themselves to research into the colloid chemistry of soil and the statistical interpretation of agricultural experiments.

ACCORDING to press reports plans have been made by the State of Vermont and the University of Vermont to make a bird and game sanctuary and a reservation for scientific nature study out of Eastwoods Park, on the southeast border of Burlington, which the university recently acquired from the Hatch estate. The work of Edward Hatch's seagull sanctuary on the Four Brother Islands named for the four brothers in the Hatch family will not be interrupted by this transfer of the Eastwoods property. Edward P. Hatch established the sanctuary for seagulls many years ago and it still is maintained by his son, Edward Hatch, of Willsboro Point, N. Y. Some time ago it was announced that the Hatch estate desired to sell Eastwoods, containing approximately ninety-two acres of land, the greater part of it heavily wooded with primeval towering pines and hemlocks. Fearing that the property would fall into the hands of lumbermen who would strip it of trees, nature lovers started a movement to save it for posterity. A group of about twenty-five patrons of the out-of-door arts cooperated financially with the University of Vermont in the acquisition of the property, in order that it might be maintained as an out-door laboratory for college students and others interested in forestry, zoology, botany and kindred sciences. President Guy W. Bailey has appointed Professor H. F. Perkins, head of the department of zoology, supervisor of the new property. He will be assisted by Professor W. R. Adams, Jr., who will have charge of the forestry program. The winding roads will remain in their present condition and the public will be welcome to hike or to ride horseback on the trails, or to visit the woods.

THE preservation of natural beauty in England by the transfer of large parks, at present owned privately, to public ownership is advocated by S. K. Ratcliffe in a report to the Royal Society of Arts. The expansion of cities, and the changing system of land ownership, which is reducing the amount of land held

by single individuals, is increasing the need for a national park policy if any large stretches of country are to be preserved for the future in their present state. The American national parks were cited as models, but Mr. Ratcliffe proposed that the national parks in England should be barred to motor cars.

DISCUSSION

HISTORY OF SCIENCE SOURCE MATERIAL IN COLLEGE LIBRARIES

DURING the past few years there has been growing in this country an appreciation of the value of the study of the historic steps whereby the physical sciences have reached their present status. English and European writers recognized the importance of this field of study at a far earlier time. School histories are giving more space to this side of human development and less to military campaigns than formerly. Science teachers have discovered the pedagogic worth of the historic method of instruction. Productive scientists of the highest class have almost invariably found it worth while to familiarize themselves with the beginnings of their particular fields of investigation. At the same time, American writers and teachers have found source material dealing with the history of science in its several branches rather difficult to obtain. The purpose of the present short paper is to suggest one means which possibly may serve to alleviate this condition.

Almost every college library contains a few rather rare books that might be of inestimable value to any one tracing the historical development of the particular science with which they deal. Unfortunately, their existence in this country is practically unknown. For example, an American scholar while in London was told by a prominent book dealer that it was doubtful if a certain work on early surgery could be obtained at any price. After returning home, this American told one of his colleagues, a professor of biology, of his search, and was informed that the library of the college with which they both were connected possessed a copy of the first edition of the desired book. There is little reason for thinking that a similar case might not occur in any college community.

There are several methods whereby rare books may become more widely serviceable than at present. A first suggestion is that science teachers everywhere glance over the bookshelves in their local libraries and list any rare and unusual books that might be even remotely useful to any one studying the rise of the modern sciences. Such lists might be grouped centrally by some agency such as the state academy of science, and copies of these also deposited in some suitable national repository. If such lists could be made fairly complete they would enable many scholars to locate much-needed source material, and they might conceivably find it near enough at home to be able to consult it without any great inconvenience.

Another method that might prove equally efficient if carried out thoroughly would be one in which the initial steps in a nation-wide canvass would be made by a committee to draw up and circulate lists of desired works. This method would not discover the unusual book or manuscript. Probably a combination of both the above schemes would prove most satisfactory.

In following either of these procedures it should be remembered that only in recent years have the various branches of science become sharply differentiated. The present artificial dividing lines may be necessary because of the enormous content of each branch. In spite of these distinctions, it is a matter of common knowledge that the so-called sciences are but parts of one all-embracing study of the world of which we are a part. As one goes back through even a few centuries he finds that specialization as we know it is less and less necessary, and the outstanding man of science is found to be a man of universal knowledge. His experiments and his writings may be contributory in the study of a number of widely divergent branches of the science of the present day. For these reasons, a bibliography for serious use in the study of the history of physical science should include the books, pamphlets and manuscripts that may throw any light whatever on the development of science in any of its divisions.

The suggestions made above really involve the carrying out of an extensive program. The details could be worked out by a suitable committee. However, there are other benefits to be derived than those mentioned. The first to profit by such a survey will be those making the local search. It is well known that a full appreciation of the science of the present depends upon a knowledge of the work and workers of the past. One of the common meeting grounds for the various divisions of science is in a study of their historical development. For this reason, every science teacher should make the maximum use of all local material of this kind. By so doing in his classes he can lay the surest foundations for technical training, and he can impart to his pupils much of real cultural value by enabling them to see what type of contributions to civilization are of lasting worth.

These arguments might be expanded indefinitely, but the purpose of the present paper is to call attention to a great opportunity in the hope that many other writers will offer suggestions out of which the real solution will come. Until the time when some capable organization can take charge of the work, correspondence through the scientific journals might accomplish much, or the present writer will welcome private correspondence which he will undertake to arrange and turn over to whatever organization may prove suitable.

E. H. JOHNSON

KENYON COLLEGE

ARE BATHOLITES UP-BULGES OF SIAL?

THE able report to the National Research Council by F. F. Grout and a discussion in Washington recently have revived in my mind a question that has been there a long time. Are the granite batholiths up-bulges of the sial layer some ten kilometers thick of which the earthquake waves have informed us, or are they intrusions of more modest dimensions—phacolites, perhaps, such as are suggested by the work of Balk and Buddington[1] in the Adirondacks? Does the coarseness of their grain throw any light?

In the theory of the coarseness of grain as affected by the rate of diffusion (of heat or mineralizers) which I developed in 1894–1896[2] which is abstracted in Fairbanks' recent book[3] I found that there should theoretically be a central belt of uniform cooling and grain, in which the size of grain did not vary with the distance from the margin. For the grain I obtained a formula:

$$E = \frac{kc}{\pi a \sqrt{u}}$$

That is, the average linear dimension of the grains (E) increases proportionally to the "power of crystallization," which depends on the composition, etc. (k), and to the linear scale of the phenomena, *e.g.*, the thickness of an intrusive sheet and its contact zone (c), but decreases with the square root of the diffusivity (a^2) and the difference between the conditions (temperature) at which crystallization takes place and those of the country rock (u). The initial conditions of the magma are not a factor! They may be much hotter.

In small aplite dikes the grain is fine because (c) is small. But in the pegmatites we may find extremely coarse grain which I take to be because (u) is small.

[1] New York State Museum Bull. 281, 1929.

[2] *Bull. Geol. Soc. Am.*, 8: 403, etc., 1897, also 14: 394–5.

[3] "Laboratory Investigation of Ores," Chapter VI, p. 123.

That is, the country rock is hot and the magma is full of mineralizing juice so that the crystallization temperature is low.

But so far as my experience goes, and that of such friends as Larsen and Laforge, in a normal even grained hypidiomorphic batholite of granite there is a rather narrow range of grain, say from 0.2 cm to 2 cm, usually about 0.8 cm. From the character of the quartz we know that (u) is less than 825° C. and probably is about 400° or possibly may get down to 200°. Its square root is then 20 ±. The square root of the diffusivity is about 0.07. From certain cases where the size of the granite dike or boss may be inferred I judge that is something like antilog − 5 ± 1, which is quite a range to be sure, but puts limits to (c). For a normal anchieutectic granite (using Vogt's term) k can not vary enormously except with the mineralizing water present, an increase of which will tend to lower (u) and also the viscosity, in other words increase (k). Thus the limit in the coarseness of their grain (hypidiomorphic and not protoclastic) would seem to put a definite limit to the depth and size of granite batholiths. I should like to have colleagues test the matter. The larger the granite batholiths are the greater the (c). The deeper they are the greater the country rock temperature and so the less the (u). In both cases the greater would be the grain. It looks as though the granites we see could hardly be direct up-bulges of a crystallized ten kilometer layer, as Van Hise used to urge and I would rather like to believe.

I will quote from a letter just received from Professor A. Holmes:

> My experience in Mozambique and knowledge of other areas like Finland by their literature suggest to me that batholiths can not be very deep, because no sign of them is to be found in the levels of the crust deeply denuded by long exposure and uplift. The rocks there are all gneisses veined through and through with thin granitic veins.

ALFRED C. LANE

ANOTHER CAPTURE ON THE NEW JERSEY COAST OF THE BASKING SHARK, CETORHINUS MAXIMUS

ABOUT 2 A. M., June 5, 1930, two fishermen (Carl Holgerson and Edwin Gustafson, of Monmouth Beach), in fishing their gill net about 15 miles south by east of Long Branch, found a large shark tangled up in it. The shark had so many fathoms of net rolled around it that there seemed nothing to do but tow it to shore and there after daylight salvage what they could of the net. After two hours' work they succeeded in getting a double half hitch of three-quarter-inch rope around the snout of the shark, and

from this they then ran two lines to the stern of their 23-foot Seabright skiff. With the big shark thus held fast, they towed it head-on to shore. But so heavy was the fish (estimated to weigh 1,800 to 2,000 pounds) and so violent were its struggles that it took their 16-horse-power gasoline engine two and one half hours to cover the distance. The great fish lived about an hour and three quarters after being dragged out on the beach.

Seeing that their catch was an unusually large shark (14 feet, 3 inches long between perpendiculars) of a kind unknown to them, they determined to exhibit it in order to recoup some of the loss of their net. Eviscerating the fish (a female) they filled the interior with "dry ice" and put it in a tent where it was seen by hundreds of people. Among the visitors was Mr. Morris Ranger, of New York City, who on Saturday afternoon (June 7) and again on Sunday telephoned the museum. The administrative and scientific staffs were away, but Mr. Ranger finally got in touch with Dr. W. K. Gregory, curator of fishes, at his home, and so accurately described the shark that it was apparent that it was a specimen of the basking shark.

On Monday, June 9, I went down to Long Branch and through the kindness of Mr. Ranger was taken to see the fish in a room in the freezer of the Monmouth Beach Fish Company where I found it frozen as solid as a log. It was a fine specimen in perfect condition save that the viscera including the reproductive organs were gone. This was very unfortunate, since thereby the chance was lost of getting at least some idea of the method of reproduction. The liver is said to have been very large, weighing about 135 pounds. The fish was then purchased from its captors and through the courtesy of Manager W. F. Carhart was held in the freezer until it could be sent to the museum.

About noon two days later (one week after its capture) the still frozen fish was delivered by truck at the museum. Being stiff as a log, the great shark held its shape and was much easier to handle than when thawed out the next morning. At this later time, however, we could manipulate the head and jaws better, and it was now possible to stuff the abdomen with excelsior and sew it up to make a cast and then to skin it. From the fish we got a color sketch, a number of excellent photographs (especially of the snout and mouth parts), a full set of measurements, the skin for mounting and the head with skull, jaws, gill apparatus and shoulder girdle intact together with the fins and vertebrae preserved in pickle. These will furnish material for a careful anatomical study of the hard parts—those attached to the skull being *in situ*.

Some measurements of this huge shark will be of interest. It was a female, 14 ft. 3 in. between perpendiculars. The girth at the angle of the jaws was 5 ft. 5.5 in., at the front edge of the pectoral the same, at the front edge of the first dorsal 5 ft. 2 in., around the "small" of the tail 1 ft. 10.75 in. The length of the first gill slit from top to bottom was 3 ft. 7 in. The first dorsal fin was 1 ft. 5 in. high. The vertical depth of the caudal measured 3 ft. 9 in. Width over head between eyes 1 ft. 4.5 in. Distance around curve of lower jaw 2 ft. 6 in. Vertical gape, jaws widely distended, 1 ft. 1 in. The estimated weight of the fish varied from 1,800 to 2,000 lbs.

When the skin of our fish has been mounted on a manikin modeled from the plaster cast and this checked by our measurements and photographs made of the fish in perfect condition, we will have in our Hall of Fishes in the museum an adequate representation of this great fish. A photograph of this together with the other pictures of the fish will then be used to illustrate an article on the natural history of the basking shark.

Historical Account of *Cetorhinus* on the New Jersey Coast

The earliest record of the occurrence of the basking shark in these waters dates back to 1822. In that year Lesueur[1] described a male specimen captured in the autumn of 1821 near Brown's Point, Raritan Bay. Although the skin had been mutilated by harpoons and bullets in the process of capture, and was further damaged in detaching it from the body, it was exhibited by the fishermen under the name of "Leviathan or Wonderful Sea Serpent" in order to get money to replace their net. The poorly mounted fish is thus described by Lesueur:

> It was, however, at length, extended upon a frame, which imitated the form of the animal, though the attitude is forced, the branchial openings too widely extended, the head too much elevated, and the mouth so much expanded as to admit a man in a sitting posture. Notwithstanding these inaccuracies however, much credit is due to the individual who prepared this skin, as it presents a good idea of the form and magnitude of this elephant shark.

However, from this mount, if such it may be called, Lesueur wrote a very accurate description and his illustration is one of the best known to me. His figures for the size of this first New Jersey specimen are: "Total length, when recent 32 feet 10 inches,

[1] C. A. Lesueur, "Description of a Squalus, of Very Large Size, which was Taken on the Coast of New Jersey," *Journ. Academy Natural Sciences Philadelphia*, 2 (pt. 2): 343–352, plate, 1822.

circumference 18 feet—of the dried skin 22 feet, and 9 feet 7 inches and 4 lines in circumference." The figures of our specimen have been set out above. Those for the girth are only approximate since the fish had been eviscerated.

The next known reference to *Cetorhinus* in New Jersey waters is a very indefinite one by Charles C. Abbott.[2] He says:

Cetorhinus maximus, Basking Shark. Occasionally in August and September, a specimen of this species is seen, but they are seldom captured. They are a northern species that are seen on our coast only as stragglers.

Fowler in his extensive work[3] on New Jersey fishes says: "This very rare giant shark, which is apparently unknown to most fishermen, does not seem to have been noted since Lesueur's time, early in the last century." Sixteen years later, however, Fowler records[4] the capture of a 17-foot specimen on April 26 about 65 miles off Atlantic City. It was taken in a purse seine which was almost destroyed by its struggles. Still later[5] the same author writes: "Several other records on the same coast [New Jersey] were from specimens in pounds [nets] at Beach Haven and Seaside Park." In a letter, Fowler says that he has no records later than those noted above.

Since the above was written, Mr. A. R. Samson, of this city, has kindly reported the capture of a specimen of the basking shark, near Bay Head, New Jersey, on July 28, 1930. Its length was estimated at from 10 to 12 feet, and its weight at about 1,300 pounds. It was taken in a net and the fishermen report that it offered little or no resistance. I have been unable to ascertain its sex. It is being held in the freezer of the Bay Head Fisheries Company for exhibit at the New Jersey State Fair at Trenton. Photographs of this fish positively identify it as *Cetorhinus maximus*. The New York newspapers report the capture of another great shark (17 feet long) off Long Branch on August 7. This is presumably another basking shark, but in the absence of photographs one can not be sure.

Cetorhinus ON OTHER PARTS OF OUR ATLANTIC COAST

Jordan and Evermann in their "Fishes of North and Middle America"[6] say of the basking shark, "Straying south to . . . Virginia." This is repeated in their "Check List," p. 20, 1930. However, they do not give any authority for this statement. In this connection, Mr. Fowler, who has a wide knowledge of the fishes of our mid-Atlantic coast, writes, "I know of no captures on the Delaware, Maryland or Virginia coasts." Furthermore, examination of faunal lists of Virginia fishes fails to confirm the statement above. Inquiry of Dr. S. F. Hildebrand, whose studies of the fishes of the Chesapeake Bay have made him conversant with the literature, brings the information that he knows of no records of the shark in Virginia waters.

Since *Cetorhinus* is an Arctic or at any rate a sub-Arctic shark, which drifts with the south-flowing inshore cold water down along the eastern coast of the United States, it is found more abundantly north of New Jersey. Thus Hussakof[7] records a specimen 14 feet long which became entangled in a bluefish net at Westhampton Beach, Long Island. There are questionable accounts of specimens at or off Woods Hole in 1906 and 1908. However, since Cape Cod forms a veritable trap for northern fishes which drift south, this shark is more abundant in the Gulf of Maine as is to be expected.

The data for its known occurrences in the Gulf of Maine have been well worked up by Allen[8] and by Bigelow and Welsh.[9] These accounts (especially Allen's very detailed one) are worthy of careful perusal. The facts therein which are of interest just here may be summarized as follows. It has been ascertained that prior to 1820 there was a regular fishery for this great shark in the Gulf of Maine for its oil and liver. From 1828 to 1920 there are listed the captures of 12 measured specimens varying in length from 14 to 31 feet. In addition there are more or less indefinite accounts of "many others" estimated at from 25 to 35 feet in length. From these data it is plain that the specimen under consideration was only about half-grown.

As has been stated, we plan to prepare an accurate mount of our skin of *Cetorhinus* to be hung at the entrance to the Hall of Fishes. The only other mounted basking shark in the United States so far as I know is the fine 26.5-foot specimen in the Boston Society of Natural History.

E. W. GUDGER

AMERICAN MUSEUM OF NATURAL HISTORY

[2] C. C. Abbott, "Fishes," in his "Catalogue of Vertebrate Animals of New Jersey"; Appendix E to "Geology of New Jersey," by George G. Cook, p. 828, Newark, 1868.

[3] Henry W. Fowler, "The Fishes of New Jersey," Annual Report New Jersey State Museum, 1905, pp. 57–59, fig., Trenton, 1906.

[4] H. W. Fowler, "A Basking Shark (*Cetorhinus maximus*) off New Jersey," *Copeia*, no. 101: 89, 1921.

[5] "Basking Shark," *Fish Culturist*, 8: 30, 1929.

[6] Vol. I, p. 51, 1896.

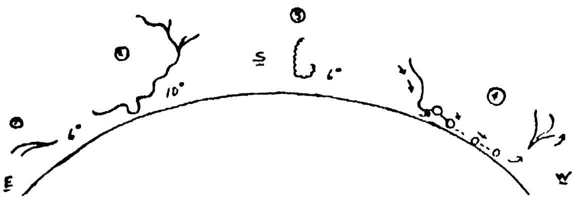
[7] L. Hussakof, "The Capture of a Basking Shark on Long Island," *Copeia*, no. 21: 25–27, 1915.

[8] G. M. Allen, "New England Sharks in the [Boston] Society's Collection," *Bulletin Boston Society Natural History*, no. 24 (*Cetorhinus*, pp. 3–8), 1921.

[9] H. B. Bigelow and W. W. Welsh, "Fishes of the Gulf of Maine," *Bulletin U. S. Bureau Fisheries*, 40 (pt. 1), (*Cetorhinus*, pp. 41–43), 1925.

OBSERVATIONS OF LIGHTNING

I AM enclosing some rough drawings of lightning as seen by me last night at Chatham, N. J. I don't imagine these are especially significant, but it was the second time in my life that I have seen ball- or chain-lightning, and the first time I ever saw any lightning as indicated in Fig. 3. This last was very snake-like,



FIGS. 1, 2 and 3.—All cloud phenomena. Fig. 4 ball or chain. Dashes indicate progress of single ball, which apparently came to earth as (O—O) a 2-ball chain, and then was dissipated in the direction of arrow in form indicated—a kind of flame. Fig. 3 is a type I have never before seen. I made these drawings at the time, during 5 storms lasting, with intervals of an average of 5 minutes, from 6 P. M. until 3: 30 A. M., July 9–10, 1930. In Fig. 2 note the U-shaped discharge. The area was as above indicated: East, South, and West. There were several zenith flashes of great intensity, the general color being white, and quite blinding.

or perhaps worm-like; I wish I could have photographed them, but drew them immediately, which was the best I could do. In this connection, one discharge, so blinding that it left everything positively black, obligingly wrote itself in black by means of vision persistency, and so I was able to put it down.

I note that Mr. Allard, in *The Scientific Monthly*, is doubtful as to the actual appearance of certain discharges, not trusting his eye. Why couldn't he have photographed the same flash that he saw, and then compared the picture with his visual impression?

My vision is super-excellent for lightning, a comparison of photographs with visual remembrance perfectly coinciding, and I am quite sure that Fig. 3 is a faithful reproduction. The U-shaped one may be common, for aught I know, but I never remember seeing anything exactly like it. These five storms were quite distinct, and not recurrent, an average interval of five minutes spacing them from about 6:00 P. M. July 9 to 3:30 A. M. July 10. The quality of the thunder referred to by Mr. Allard changed from what I may characterize as heavy paper-tearing to dull, heavy, jarring echoes which made a distinct impact on windows and doors. I had the radio turned on—a very sensitive set—and got the discharges instantly, *i.e.*, evidently at the exact time of the explosions, the actual sound not reaching me until some time after the radio sound. I estimated the average distance, with one exception, at 2½ miles, and it was easy to prove that the radio emanations were those of the actual discharge. One or two flashes were so swift that I was virtually unable to see them, although looking directly at them, seeing them only by persistence of vision, as above noted.

The one exception above mentioned came after a five-minute interval of absolute quiet (rather exceptional), and struck a tree 50 ft. distant, cutting it directly in half, laterally, which I believe is also unusual. The sound of course was no more than a whipcrack.

HAMILTON CRAIGIE

JULY 10, 1930

COCOS AND VALENCY

I WISH to call attention to two statements in the August 1 issue of SCIENCE. In reference to the generic name *Cocos*, Murray's dictionary, which devotes much space to a discussion of the source of the word, states that Spanish and Portuguese authors are unanimous in the opinion that it is derived from the Spanish noun *coco*, "grin," on account of the face-like markings at the base of the fruit.

I wish, however, specially to protest against the inference to be derived from the statement on page 101 (Professor Fajans' lecture) that the sole honor of the suggestion of the doctrine of valency is due to Kekulé. It is clear that Frankland in his paper presented to the Royal Society in 1852, detailing the discovery of the organo-metallic bodies, embodied such statements as entitle him to the honor of setting the theory of valency in notice. It is also worthy of note that Couper in 1858 first set forth (in *C. r.*, 46: 1157, 1858) the use of bonds connecting atoms in the manner of our now familiar structural formulas.

HENRY LEFFMANN

SCIENTIFIC BOOKS

Die Paläobotanischen Untersuchungsmethoden. DR. RICHARD KRÄUSEL. Jena, Verlag von Gustav Fischer, 1929.

AN important feature of post-bellum developments in Germany is the issue of a number of admirable handbooks and general works which are usually constructed with great thoroughness. A recent addition to this group of works is a small but important volume by Professor Richard Kräusel, of the University of Frankfurt am Main. In it he treats in a thoroughly satisfactory way of paleobotanical methods of investigation. A work of this sort is obviously much needed, as the literature on the subject is very

widely scattered and has been developed not only at the hands of the paleontologists proper but also by botanists. The work under consideration begins with a statement in regard to the bearing of paleobotany on a number of important theoretical and practical problems such as stratigraphy, sedimentation, the origin of coal, paleoclimatology and paleogeography. There follows an excellent account of methods of fossilization and preservation of fossil plants. In spite of its necessarily brief character this exposition is carried out in a masterly fashion. Following this is an account of the methods of collecting fossil plants. This is subdivided into older fossils and peat, each of which of course has its own particular methods of procedure.

A very important chapter is that which deals with methods of research. This is most comprehensive and covers bleaching, photography, the use of fluorescence and Roentgen rays. The investigation of peat and more recent material comparable with it also figures in the account. Naturally a very important part of this chapter deals with anatomical and microscopical investigation, and that must rank as one of the most important parts of the book since it treats in a thoroughly satisfactory way all the technical methods which have been developed in connection with the investigation of fossil plants, particularly those which are of more recent origin. Under this heading naturally come the preparation of thin sections, the preparation of polished surfaces, the use of etching methods and the preparation of relief surfaces. Under the heading of maceration the methods of Walton and Ashby, to some extent founded on those developed by Nathorst in earlier years, are described. Under the heading of preparation of thin sections the various new developments which have added greatly to our knowledge of fossil plants are satisfactorily described. This chapter ends with microchemical methods which are a comparative novelty in paleobotany but destined to have an important future.

The fifth chapter is especially devoted to coal and its constituents. It is of interest to note in this connection the author's open-mindedness which becomes apparent in his remarks in regard to Tertiary brown coal. He pointedly asserts that it is no longer possible to regard the brown coal deposits of the northern hemisphere as derived from formations comparable with the Dismal Swamp of America. This point of view is refreshing in relation to the extremely reactionary attitude of the mass of American geologists in regard to recent investigations on coal. One wonders if the United States will have the undesirable preeminence of being the last country to adhere to the *in situ* hypothesis of the origin of coal, just as it was the last country to adhere to the seed-bearing character of arboreal cryptogams such as the Lepidodendrids and Calamites. It has been wittily remarked that Oxford is the place where good German theories go when they die. As far as paleobotany is concerned, the United States appears at the present time to rival that ancient institution of learning.

The volume under review contains, in view of its size, a large number of illustrations which visualize not only the apparatus used in various paleobotanical investigations, but also results which have been obtained by the apparatus and methods described in the volume. The author is to be congratulated on producing a much needed and extremely valuable work which will be indispensable to all geologists and paleontologists who are in any way interested in fossil plants.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN INDIVIDUAL JACOBSEN GERMINATOR

THE Jacobsen apparatus for testing seeds has certain advantages over other methods which have led to its adoption, especially in Europe, in seed control stations. For forest seeds in particular it has proved the most satisfactory method. Its advantages may be summed up in the statement that it permits better control, and thereby standardization, of the physical conditions for germination, especially moisture and oxygen supply.

The apparatus as generally used consists of a large pan, ordinarily of zinc or galvanized iron, kept filled to a certain level with water. A constant level can be maintained conveniently by means of a Mariotte flask arrangement. Wicks attached to small cotton pads are supported on glass strips or on a perforated cover, and dip into the water. In some modifications, *e.g.*, Toumey's, other arrangements of wicking are used to furnish the water supply. The sample of seed is placed on a filter paper or special blotter in contact with the wick and covered by a small glass bell jar having a small aperture in the top. The distance between the seed and the water level determines the rate at which water can be supplied to the seed. Temperature is usually regulated by heating or cooling the water in the pan.

Certain difficulties have been met with by the writer during continuous prolonged operation of the apparatus described above. In spite of frequent changes of water, corrosion of the zinc or galvanized iron results in the formation of a scum which interferes with the normal absorption of the wicks and makes frequent changing of them necessary. Wicks are very likely to go dry when they become encrusted with this matter. Coating the pan with an acid-proof paint and frequent changes of water do not obviate the trouble entirely.

In experiments in germinating seeds in various buffered solutions, when it was essential to avoid contact with metals which might alter the solutions, glass bottle germinators were improvised which have proved to have several advantages. Large-mouthed bottles or mason jars having a top 8 cm or less in outside diameter are suitable; flat or ground edges are preferable, but not necessary. The jar (A) is filled with

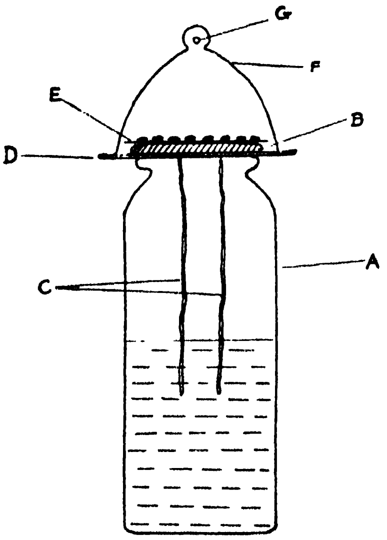

FIG. 1

water or solution to a predetermined level marked on the glass. The knitted cotton pad (B) with wick (C) attached is supported on a small glass disk (D) having a 2.3 cm hole in the center. Such disks, known as bobeches, are used on candlesticks to catch drip, and can be purchased from china stores for 10 cents each. The bobeche is prevented from slipping by coating the top of the bottle with thick desiccator grease. The filter paper (E) bearing the seed sample is covered by a small bell jar (F) having a perforation (G) in the apex. If necessary, this can be prevented from slipping on the bobeche by sealing with grease.

As an alternative any appropriate vessel can be used, covered with a perforated glass or porcelain plate. Having holes drilled especially is usually more expensive than using the ready-made bobeches. An inverted glass funnel with the stem filed off can be substituted for the bell jar with perforation. Just as in other forms of the Jacobsen apparatus the rate of moisture supply is regulated by the height of the absorbing pad above the water surface. The vessel should be sufficiently deep to accommodate the space desired.

The advantages of this type of germinator may be summarized as follows. (1) Each apparatus is a unit, fulfilling the conditions of the Jacobsen apparatus in a minimum of space.

(2) Since the moisture supply is completely enclosed, loss by evaporation is restricted to the germinating medium, from which water vapor diffuses out of the hole in the bell jar. This loss is so small that a concentration of salts on the surface is avoided. Water loss is so small that tests have been run a month without essential change in water level.

(3) The wick leading to the germinating pad is at all times in a saturated atmosphere, protected from dust and dirt. The entire apparatus may be sterilized in an autoclave before sowing the seed. Covering the jar with black paper will also aid in preventing bacterial action.

(4) The entire system being of glass and clean cotton, chemical action is minimized.

(5) In the case of the use of solutions made up with CO_2-free water, the enclosed reservoir increases the time they may be maintained unchanged.

(6) Individual units are more convenient to move about while tests are in progress. They may be placed in ovens under different temperatures and removed to others during part of the day to provide alternating temperatures; they may be immersed in cooling solutions for chilling treatment; light and dark may be alternated, etc. In other words, seeds may be tested with the mobility characteristic of petri dish cultures, without losing the superior control obtainable with the Jacobsen system.

As disadvantages may be mentioned the danger of breakage and the greater care necessary in changing wicks because of the less stable containers. Uniformity of moisture conditions for a large number of duplicate samples might possibly be obtained better under one common container. This would require specially made, more expensive apparatus.

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DETECTION OF FUNGUS MYCELIUM IN MILDEWED COTTON FABRICS

IT is sometimes difficult and time-consuming to demonstrate the presence of mold mycelium in mildewed

cotton or cotton fabrics by ordinary microscopical examination in cases where surface growth is not present. In such cases, and also when it is necessary to determine the extent of infection, differential staining followed by microscopical examination is desirable. For this purpose, Bright[1] recommends the use of cotton blue or picronigrosine for staining, mounting the material in Canada balsam, and examining with the 2/3 inch (16 mm) objective. Color filters may be used to obtain greater contrast.

We have found that the Pianese IIIb stain,[2] which is used by plant pathologists in studying sections of tissue infected by fungi, is also a good differential stain for the above purpose. This stain contains martius yellow, malachite green and acid fuchsin.[3] The material under examination is washed in water or alcohol (preferably alcohol), stained for 15 to 45 minutes, washed in water, decolorized in acid-alcohol and dried, after which it may be mounted for examination in Canada balsam or gum damar. Cotton fibers stain green and the fungus mycelium a deep pink, a color filter not usually being necessary for contrast. A good source of light is important.

With this stain the presence of fungus mycelium in raw cotton and undyed yarns and fabrics is easily and quickly demonstrated. It is desirable in heavy fabrics to tease the fibers apart before mounting. Dyed cloth is sometimes more difficult to examine, but fungus, if present, can usually be demonstrated.

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SPECIAL ARTICLES

CHANGING THE CHIRP-RATE OF THE SNOWY TREE CRICKET OECANTHUS NIVEUS WITH AIR CURRENTS

IT has long been known that the intermittent chirping rate of the snowy tree cricket varies rather consistently with changes in air temperature; Margarette W. Brooks,[1] of Salem, Massachusetts, was the first observer to present in a scientific magazine an account of the rate as affected by different temperatures. Strangely enough, although many scientific discussions have followed up to the present time, every one has consistently failed to make any reference to her pioneer discussion, even though little has been added since her day.

While the rate of chirping unquestionably shows a marked temperature correlation rising and falling with similar changes in temperature trends, the crickets are very erratic organic clocks and show various discrepancies in their rates which have never been explained. Every individual cricket, like every clock or watch, must be regarded as a specific mechanism with specific modes of behavior. These have become geographic correlations in some instances so that in different portions of their range the rates of chirping appear to be physiologically established racial behaviors, as pointed out by Fulton.

Careful observations even in the same locality reveal occasional discrepancies from the expected rate which have never been satisfactorily explained. A. F. Shull[2] in 1907 studied these tree crickets very intensively in Michigan, Ohio and New York. He found that observed air temperatures did not explain the entire situation and found that a higher rate now and then may accompany a somewhat lower temperature. In my own studies I have likewise found that on different evenings with air temperatures at 70° the rate may range from 121.7 to 133.7 chirps per minute.

These variations have puzzled me not a little, and during the summer of 1929 I made a few preliminary tests with air currents. A small electric fan was purchased and a snowy tree cricket showing a ready willingness to chirp when confined in a room was placed on some raspberry shoots in my sleeping room where outside air currents could not introduce errors. Using a stop watch a number of counts were then made of its normal chirping rate for these conditions to establish a system of channels. Following this, a current of air was directed upon the cricket from the fan placed about 6 feet away so that it produced an evident motion in the foliage surrounding it. Almost immediately the cricket responded to the air currents by accelerating at once its chirping rate in a very evident manner.

After counts had been made the fan was turned off and the cricket allowed to chirp for a few minutes until the normal rate of chirping in still air could be resumed. The return from the higher rate seemed to require a somewhat longer time than was required to establish it when the fan was turned on.

[1] T. B. Bright, *Jour. Mic. Soc.*, 141, 1925.

[2] R. E. Vaughan, *Ann. Mo. Bot. Gard.*, 1: 241, 1914.

[3] H. J. Conn, "Biological Stains," second edition, 1929.

[1] "Influence of Temperature on the Chirp of the Cricket," *Popular Science Monthly*, 20: 268, November, 1881, to April, 1882.

[2] *Canadian Entomologist*, 39: 213–225.

CHIRPING RATES OF SNOWY TREE CRICKET AS AFFECTED BY A GENTLE CURRENT OF AIR FROM A SMALL ELECTRIC FAN. TIME 11–11: 30 P. M. AIR TEMPERATURE IN ROOM 74° F.—RELATIVE HUMIDITY UNKNOWN

Period	Conditions	Chirps per minute in individual counts	Mean
first	without fan	172, 172	172
first	with fan	192, 188	187
second	without fan	174, 170, 172	172
second	with fan	186, 188, 180	184.6
third	without fan	172, 172, 172	172
third	with fan	180, 188	184
fourth	without fan	174, 174, 172	173.3
fourth	with fan	184, 184, 184	184
fifth	without fan	176, 172, 170	172.6
fifth	with fan	182, 186, 180, 186	183.5
sixth	without fan	172, 172, 170	171.3
sixth	with fan	182, 188, 188, 188	186.5
seventh	without fan	172, 172, 170, 168	170.5
seventh	with fan	182, 188	185

Mean of all counts without fan: 171.9 chirps per minute.

Mean of all counts with fan: 185 chirps per minute.

It is seen that the mean chirping rate has been increased from about 172 chirps per minute to 185 chirps, a difference of 13 chirps above the normal rate in quiet air. The mean acceleration per degree rise of temperature as determined from all available records for the snowy tree cricket is very close to 4 chirps per minute. An increase of 13 chirps following the turning on of the fan to create a breeze is closely equivalent to a rise in temperature of about 3 degrees.

These results were somewhat startling to me, for I had expected a fall in the rates of chirping rather than a rise; I had surmised that moving air currents directed upon the cricket would increase the evaporative rate, tend to chill the cold-blooded creature and depress its activities as reflected in the rates of chirping.

These results agree well with casual observations made in the field with various intermittent chirping crickets, namely, the snowy tree crickets (*O. niveus*) and the tiny tree crickets *Cyrtoxipha gundlachi columbiana*. Many times I have noted a sudden speeding up of the chirping rates as a breeze swept over the foliage on warm evenings. The transportation of a warmer air mass to replace a cooler could operate, but as the room tests have shown, it may even depend upon moving air at constant temperature.

In a test made later in the season out-of-doors, the fan was arranged to blow a current of air upon a chirping cricket on a shrub. At this time, however, the moving air currents produced no changes in the rates of chirping of the cricket.

It is obvious that the matter is not as simple as might at first appear, and it is possible that temperature and humidity must bear certain relations to air motion to determine whether or not retardation or acceleration of the chirp-rate per minute will occur.

It is interesting to note that A. F. Shull[3] found certain obvious discrepancies in the rates of chirping at different elevations which were not explainable on the basis of observed differences in air temperature. Whereas the difference in temperature between crickets at an elevation of two feet and those at 10 feet was only 1°, which should have increased the rate but 4 chirps at the higher point, the increase was actually 17 chirps. In his discussion of humidity Shull (p. 220) studies chirping crickets at 6 and 12 feet elevations. The first set of data was made with a clear sky and no air currents. Two hours later a second set was made when the temperature at the higher elevation had fallen about 2.2°, attended by light winds and rain. The change in temperature at 12 feet would have accounted for a decrease of but 9 chirps per minute, but the actual decrease had become 20 per minute.

Shull was inclined to believe that increase in humidity decreased the rate of chirping, and consequently would account for the lower rates observed at an elevation of 2 feet as compared with 10 feet. He believed that the greater depression at 12 feet over that at 6 feet was likewise due to an increased humidity.

My own results and those of Fulton appear to indicate no correlation between normal out-of-doors conditions of relative humidity and the rate of chirping. At very low humidities such as are not usually experienced by the crickets out-of-doors the relations may be very different, however. It may be stated that some phase of the matter of wind velocity may account for some of the discrepancies observed by Shull. Before any final statements can be made, the behavior of the crickets must be noted in constant air movements at different levels of temperature and humidity. An acceleration in the rate at one temperature and humidity level may be replaced by a depression at some other level.

Since the crickets, like other insects, are cold-blooded creatures, their temperatures tending to assume the levels of their conditions, it is not hard to conceive of relations between air temperature and humidity where air currents by increasing the evaporative processes would chill or benumb the crickets to

[3] "The Stridulation of the Snowy Tree-Cricket, (*Oecanthus niveus*)," *Can. Ent.*, 39: 213–225, 1907.

a greater or less degree. This may well not hold at all temperature and humidity levels, however.

When air currents blow upon them it is not so easy to see why the crickets under some conditions are stimulated to greater physical exertion as evinced by an increase in the chirping rate. Is it possible that the air currents make them more comfortable by cooling their bodies, under some conditions, just as it sometimes affects our own moods? It is at least indicated that air movements in some manner may at times operate to change the rate of chirping, and this factor may perhaps explain in part some of the discrepancies observed where the rates have changed out of proportion to the changes in air temperature.

While it is obvious that air temperature alone is not the only factor operating to make our cricket thermometers accurate, we are not justified in minimizing the air temperature factor, however. The evaluation of one factor in any environmental complex without due regard to all others can only result in confusion.

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U. S. Department of Agriculture

FRUIT-BUD FORMATION IN THE STRAWBERRY IN SPRING IN SOUTHEASTERN STATES

After the strawberry season is entirely past in Maryland one may travel either southward or northward and find strawberries just ripening. Even in Florida where the ripening season starts in November, berries may still be harvested as late as July. It is evident that the processes of fruit-bud formation and fruit development in the South take place under different conditions from the same processes in strawberries growing farther north.

In various sections of the Northern states from Maryland to Iowa and northward, the terminal growing points of strawberry plants have been found to begin transforming from vegetative buds to fruit buds in late September and October. In Florida the varieties there evidently initiate fruit buds continuously throughout late fall, winter and spring, as flower cluster production is a continuous process from November until June. From Georgia to North Carolina winter temperatures are cold enough to enforce short dormant periods, but the fruit-bud formation of fall is again resumed as soon in the spring as the temperatures become high enough for growth. From Virginia northward there seems to be no period of spring fruit-bud formation, and consequently no second crop.

The work of Garner and Allard,[1] and work previously referred to in this periodical[2] on effects of the length of the daily light period on plant growth, have furnished a background for an explanation of this late spring fruiting of the strawberry in the South. This work also furnishes one reason why strawberries vary so greatly in yields in different localities.

Fruit-bud development does not begin in the spring-bearing varieties to the north until the daily light period becomes relatively short in the late fall, and it ceases as soon as the temperature is as low as freezing. It would seem that conditions of similar day length and temperature following a period of winter dormancy might influence strawberry-plant activity in the same manner as preceding the dormant period. The following observations give evidence that fruit-bud initiation is resumed in the Southeast from Georgia northward to North Carolina in early spring while the temperatures are still low and the length of the daily light period still short. North of eastern North Carolina, the daily light period is too long for fruit-bud initiation in spring-bearing varieties when favorable temperatures for growth occur.

Missionary and Klondike, the only varieties produced commercially in the Southeast, have little or no rest period and grow freely during the short days of winter when the temperature is high enough. In the spring their fruit buds that formed in the fall and early winter develop into the "ground bloom" and the "ground fruit," terms that refer to the flowers and fruit lying on the ground. The ground bloom of all varieties observed is produced chiefly, if not entirely, on basal-branching clusters,[3] the flowers of which often open in considerable numbers during the late fall and winter months and of course are killed by freezing temperatures where they occur. From Georgia to North Carolina there appears a second crop of bloom and fruit known as the "crown bloom" and "crown fruit." This fruit is produced mainly on high-branching clusters with stout erect stems which support the berries unless they are too large and heavy.

The most vigorous plants produce low, but not basal-branching clusters (at least not usually) that resemble those of the ground bloom but which of course appear later. The extent of the crown bloom varies from year to year, depending on conditions little understood, though both the vigor of the plants in the fall and the weather conditions in winter and spring affect the amount of fruit buds produced in the spring. At Willard, North Carolina, the initial stages of fruit-bud formation have been found as late

[1] W. W. Garner and H. A. Allard, "Further Studies in Photoperiodism: The Response of the Plant to Relative Length of Day and Night," *Jour. Agr. Res.*, 23: 871–920, 1923.

[2] G. M. Darrow and G. F. Waldo, "The Practical Significance of Increasing the Daily Light Period of Winter for Strawberry Breeding," Science, 69: 496–497, 1929.

[3] G. M. Darrow, "Inflorescence Types of Strawberry Varieties," *Amer. Jour. Botany*, 41: 571–585, 1929.

as April 27, which is over a month after the first ripe berries were picked. Here small fruit buds just appearing from the crowns may be observed as late as the first week in June.

When a collection of varieties is grown, very interesting differences in the length of time during which fruit-bud formation occurs become evident. In 1929 a considerable number of varieties were fruited near Albany, Georgia. The season proved to be one in which the varietal response to conditions was especially marked. Yield records, kindly furnished by Mr. J. L. Pelham, showed clearly the importance of these phenomena. The comparative yield records in pints (for fifty feet of row) for four representative sorts are given in Table I by weekly periods.

TABLE I

WEEKLY YIELDS OF FOUR STRAWBERRY VARIETIES OVER A TEN-WEEK PERIOD AT ALBANY, GEORGIA, 1929

	April				May				June		Total yield pints	Percentages of total in second crop
	1–6	7–13	14–20	21–27	28–4	5–11	12–18	19–25	26–1	2–5		
U. S. D. A. No. 25	5.0	3.0	4.5	2.0	1.5	0	0	0	0	0	16.0	0
U. S. D. A. No. 261	0.5	2.0	13.5	10.5	11.5	2.0	0	1.0	4.0	3.5	48.5	17
U. S. D. A. No. 655	6.5	10.0	9.0	3.0	2.5	1.0	4.0	9.5	10.0	5.0	60.5	47
Blakemore	13.5	5.5	6.0	1.0	3.0	3.5	9.0	12.5	10.0	4.5	68.5	63

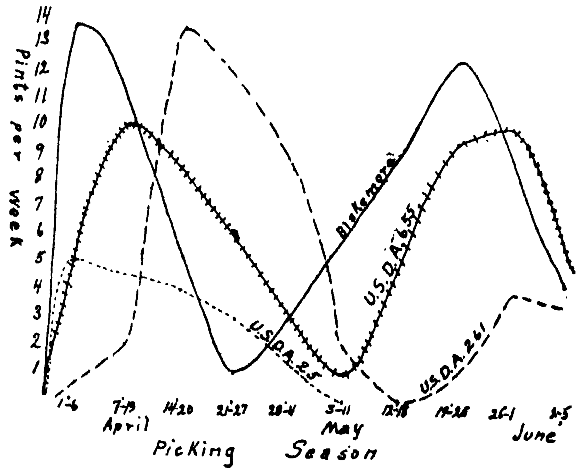

FIG. 1

The first variety, U. S. D. A. No. 25, which is a distinct spring-bearing variety that produces fruit buds only in the fall, is very productive and early in Maryland. In Georgia, however, it produced a very small crop, only 16.0 pints and that mostly early in April. It produced no late crop. U. S. D. A. No. 261 is a very productive late variety in Maryland, which is late also in Georgia. Toward the end of May and early in June it produced a small crop of late fruit. U. S. D. A. No. 655 is a very productive early sort in Maryland which in Georgia produced a large, fairly early crop and another large later crop. This variety is capable of forming fruit buds in both fall and spring. Finally the Blakemore, which is a productive early sort in Maryland, produced a large very early crop and a second larger late crop. Some fruit of both U. S. D. A. No. 655 and the Blakemore was picked each week from April 1 to June 5. However, the low point of cropping of the Blakemore was two weeks earlier and its second crop was larger than that of U. S. D. A. No. 655. The percentages of the total yield of each of the four sorts which were produced by the late crop were 0, 17, 47 and 63, respectively.

In an early season like that of 1929 a variety with the general characteristics of the Blakemore is especially desirable in the South for it produces a large early crop before berries in regions farther north begin to mature. The later second crop which is probably produced from fruit buds differentiated in late winter can then be used for the frozen storage industry. In late seasons like that of 1928 the crops from fall and spring-formed buds may overlap. Both the U. S. D. A. No. 655 and the Blakemore originated as crosses of the Missionary and Howard 17 and have inherited from the mother parent the tendency to form fruit buds in the spring. All other selections of the same parentage also form fruit buds in the spring in North Carolina and southward. On the other hand, several crosses of the Klondike with other varieties have either not shown this tendency or have shown it in a slight degree only. The production of spring-formed fruit buds seems to be due to the ability of certain varieties to respond to conditions in early spring favorable for fruit bud initiation which are similar to conditions prevailing when the first fruit-bud formation took place in the fall.

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FOREST PATHOLOGY[1]

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FOREST pathology is a comparatively new branch of forestry science in the United States, yet within the brief span of its development in this country and in other countries of the globe there has been an imposing amount of literature contributed on this subject. Like the science of bacteriology, forest pathology emerged from a cloudy mass of misunderstanding then known as the theory of spontaneous generation and began a comparatively rapid development leading to its present height.

It is not strange that in the period when living organisms of a low order associated with putrefaction of matter, fermentation and disease of man, beast and insect were believed to have originated spontaneously that the same theory should be applied to the lower organisms found associated with the decay of wood and with tree diseases. In 1833, Theodore Hartig, a forester and professor at Braunschweig in Germany, was the first investigator to study and record the occurrence of mycelium in wood. Under the influence of the Ungerian period he concluded that the organisms represented by these fungous threads developed by means of spontaneous generation from the rotted wood. He described this as the "breaking up of cell structure into balls or monads which later form rows and fuse to form fungus hyphae." Although an erroneous concept this was the beginning of forest pathology.

The early work in a newly occupied forest area is often given over to a survey or inventory type of inquiry which is frequently mycological in nature. This is an essential part of the knowledge of the tree-inhabiting fungi found in any forest area. Since much of the mycological ground has been broken in the earlier development of forest pathology, there remains relatively less to be done in the future, and a greater share of the pathologist's time will presumably be devoted to the pressing problems in forestry that call for pathological study.

[1] Presented before the Symposium on Forest Trees, Pacific Division of the American Association for the Advancement of Science, at Eugene, Oregon, June 19, 1930.

The introduction into this country of epidemic types of tree diseases, such as the chestnut blight and the white pine blister rust, developed for the emergency period a combat or battle front type of pathologist who gave much thought to control methods. The rapid spread and destructive action of the chestnut blight fungus left little time for long period investigations, and such work had to be deferred until emergency control measures could be put into effect. The blister rust, slower moving and presenting an easier problem on account of its heteroecism, gave more opportunity for experimentation and investigation. The data obtained from studies made on this disease in the eastern states have proved of immense value in formulating control plans to check the invasion of the rust into the white pine regions of the western forests during the years from 1921 to 1929.

The earlier developments in forest pathology, therefore, were somewhat influenced by the introduction of these two destructive diseases into our eastern forest regions, and by the field studies of the wood-rotting and bluing fungi. During this earlier period were laid the foundations for the studies in the physiology of fungi and the beginnings in wood pathology. Mycological contributions were well represented, and some excellent work on the control of seedling diseases left its mark.

The application of forest pathological principles to the forestry problems peculiar to our country was first made by Dr. E. P. Meinecke, whose "Forest Pathology in Forest Regulation"[2] sounded the keynote in forest sanitation and forest hygiene. This able analysis of our problem in tree diseases, particularly applicable to the virgin and newly logged areas of the West, was soon followed by systematic studies of the decay factor in our timber stands in various parts of the country.[3]

The general trend is in the direction of more detailed and well-controlled investigations covering all fields of forest pathology with emphasis upon the problems presented by the epidemics in our forests and the part played by pathology in the regulation and management of our federal, state and private forests. The demand for solutions to the many problems confronting the lumber industry and the need for conserving our timber supply by preventing the waste in forest products brought about by decay and stain is making itself felt, and a well-rounded investigative program is being followed by federal and other agencies.

A keener consciousness of the need to guard against the introduction to the United States of tree diseases common to foreign countries is being developed and steps are being taken by the federal agencies to obtain knowledge of the causal fungi beforehand so that epidemics similar to the chestnut blight and the white pine blister rust may be avoided. We have another potentially destructive disease recently introduced from Europe and becoming dangerously active on our native conifers in the New England states. This new menace which threatens our vast western forests as well as the eastern is the European larch canker, so destructive to European larch that this tree has almost ceased to be grown in Germany. Fortunately, quick and determined action on the part of federal and state agencies has resulted in the eradication of all the trees known to be infected in the New England region.

The earlier work in forest pathology was confined almost entirely to the etiology of a given disease and to the descriptions of causal organisms, with little or no attention given to the effect of the agency upon the tree. Later on, more attention has been directed to the effect produced on the host, but it has been largely a study of the effect upon the individual tree rather than an economic study of the losses, both present and future, occurring in the forest as a whole. Meinecke[4] has stressed this point in a discussion of forest pathological problems, and although he states that no standards exist by which the relative importance of a certain disease may be determined, yet not all forest tree diseases can be of equal importance with respect to their destructiveness.

The relative importance of any particular forest disease or damage must always be measured in terms of the economic loss produced. As the factors of most weight in judging the importance of tree diseases, Meinecke lists the economic value of the species affected, the character of the injury and the aggressiveness of the agency of disease. Many of the diseases common to our forests are of no great economic importance—the actual losses over a period necessary to grow a crop of timber being very small. Such diseases may cause serious damage to individual trees only and so may be regarded in the light of pests, or diseases of minor importance.

The fact that some of these enphytotic diseases act as thinning agents in crowded stands[5] reduces to some

[2] E. P. Meinecke, "Forest Pathology in Forest Regulation," *U. S. Dept. Agr. Bul.*, 275: 1–62, 1916.

[3] J. R. Weir and E. E. Hubert, "A Study of Heart Rot in Western Hemlock," *U. S. Dept. Agr. Bul.*, 722: 1–39, illus., 1918; "A Study of the Rots of Western White Pine," *U. S. Dept. Agr. Bul.*, 799: 1–24, 1919; J. S. Boyce, "The Dry-Rot of Incense Cedar," *U. S. Dept. Agr. Bul.*, 871: 1–58, illus., 1920; "A Study of Decay in Douglas Fir in the Pacific Northwest," *U. S. Dept. Agr. Bul.*, 1163: 1–18, illus., 1923; "Decay and Other Losses in Douglas Fir," *U. S. Dept. Agr. Bul.*, (in press), 1929.

[4] E. P. Meinecke, "Basic Problems in Forest Pathology," *Jour. For.*, 15: 215–224, 1917.

[5] E. P. Meinecke, "The Evaluation of Loss from Killing Diseases in the Young Forest," *Jour. For.*, 26: 283–298, 1928.

extent the total damage they do. However, tree diseases should never be regarded as beneficial factors in a stand, for with the swift changes that are being brought about in our timbered regions due to rapid removal of timber by fire, logging and other means, there is no assurance that the particular disease in question may not, under favorable conditions, become epidemic in its nature and sweep over an entire area.

One investigator concludes that the fungus, *Cenangium abietis*, attacking the lower branches of *Pinus ponderosa* in the southwest regions acts as a pruning agent and assists the tree in clearing more rapidly the lower trunk, thus improving the value of the trunk for saw log purposes.[6] This fungus, it is stated, is weakly parasitic, attacking only those branches in the lower crown which have been weakened by drought or other causes.

A large number of leaf and twig diseases cause minor damage in a stand. There are certain needle diseases, however, which in favorable years take on the nature of an epidemic and cause sufficient economic loss to be classed as important. Forest tree rusts have been observed to increase in favorable years and to cause an increased amount of damage.

The two most important causes of native tree diseases are the mistletoes (*Phoradendron* and *Razoumofskya*) and the fungi. The latter include the parasitic leaf, twig and stem diseases; the heartrot and saprot fungi and the rust fungi. By far the greatest economic damage is produced in standing timber by the decay organisms, the heartrot and saprot fungi. Trees killed by parasitic agencies may be salvaged if cut soon enough, but there is little or no salvaging of the portion of a tree trunk infected with decay-producing fungi.

The startling fact that the enphytotic diseases are all native to this country and that the epiphytotic diseases are those which have been introduced to us from foreign countries again emphasizes the need for more careful and effective preventive methods and quarantine regulations in order to prevent these undesirable and very destructive diseases from crossing our borders.

The white pine blister rust, the chestnut blight and, potentially, the larch canker are the most important of all our tree diseases, judging them by the damage produced, the species of tree involved and the comparatively brief periods of attack. And all three of these diseases have been brought to us from foreign countries.

ECONOMIC LOSSES

It has been pointed out that there are a few tree diseases of major importance and many of minor importance in our forest areas. This distinction, although based mainly upon the relative value and accessibility of the tree attacked and upon the amount of damage produced by the disease agency, is primarily judged by the direct economic loss measured in terms of timber capital lost. Protection of forests and conserving water and game for our use and recreation also possess a distinct value, although their value in terms of merchantable products may be nil. Our present timber capital consists of 138 million acres of virgin forest, 250 million acres of second growth and 81 million acres of potential forest now classified as waste. In this remaining stand we have, in saw timber and cordwood, about 740 billion cubic feet. The drain on our forests amounts to something over 25 billion cubic feet annually, and our supply of softwood saw timber alone is being cut 8.6 times faster than we are growing it. Our annual growth of timber is approximately 6 billion cubic feet. If we are cutting our timber several times as fast as it grows[7] our timber capital will vanish rapidly.

The once magnificent stands of virgin softwood timber east of the Rocky Mountains have been removed. Waste land and second-growth timber have taken their place. What has been the history of the forest areas in the Atlantic states and the Lake states is in progress of fulfilment in the southern hardwood and pine belt now largely coming into second-growth timber. The Pacific Northwest holds the bulk of the nation's timber capital, mostly virgin timber, much of it overmature and deteriorating rapidly as heartrot fungi and other disease agencies take their yearly toll. Since the risk of loss through diseases is cumulative, and decay in a mature stand increases with increase in age of the stand, it follows that our virgin stands of timber—our principal timber capital—must suffer much greater loss through disease than the young growth which is as yet of somewhat uncertain value.

However true this may be, as foresters we can not overlook the responsibility of keeping the future stands of timber healthy and producing a maximum yield of sound timber. The passing of the veteran stand often leaves to the oncoming crop of young timber a legacy of disease and injury which affects the future productivity of residual and reproduction stands. But the danger of any great loss due to decay in young stands is considerably lessened by the shorter cutting cycle, for the future generations will cut their timber long before the age attained by our present virgin stands. To offset this, such diseases as the white pine blister rust are particularly destructive to young growth, and protection must be given

[6] W. H. Long, "Self Pruning of Western Yellow Pine," *Phytopath.*, 14: 336–337, 1924.

[7] Forest Service, "Wood Waste Prevention," pp. 1–29, illus., National Conference on Utilization of Forest Products, 1924.

the reproduction areas in order to insure our future timber capital.

The two main divisions of loss evaluation due to disease agencies are the losses in standing timber and the losses in wood products. The compilation of loss figures is therefore complicated on one hand by the great differences in complexity of forest conditions for the various forest regions and by the multiplicity of products produced from wood, and on the other hand, by the large number and variety of destructive agencies responsible for these losses.

Relation of Losses to Forest Depletion

In summarizing the evaluations for both the forest losses and the losses in wood products, it is found that the annual loss equivalent in cubic feet of standing timber is as follows:

Loss in timber stands, including losses due to diseases, decay, fire and insects	2.4 billion
Loss in wood products due to decay of wood in service and in storage	4.0 billion

We are faced, therefore, with a total annual drain on our forests of over 6 billion cubic feet. The replacement of this wasted material necessitates the cutting of additional timber from our forests and in some cases causes premature harvesting of stock which would better have been left to develop for a future cutting. Every rotted tree that is cut down and culled means that another sound tree of the same board feet content must be felled to take its place in terms of wood products. In Idaho alone the loss by decay in the standing timber is estimated at approximately thirteen million board feet annually. The thousands of board feet of sapwood lumber which are annually degraded on account of sap stain must be replaced by clear lumber to supply the demand for high-grade clear stock. This means that more trees need to be cut in order to obtain the proper proportion of these grades. To the bluing of sapwood, therefore, may be laid a certain overproduction of lower-grade stock and a considerable portion of the annual cut of timber which could otherwise be reserved for future use.

The losses through improper storage of wood or through improper handling or poor design and use in building construction, losses through deterioration of stored pulp or through degrade due to sap stain, and losses due to failure to use wood preservatives all tend to hasten the exhaustion of the nation's supply of raw material.

To a progressive nation, and to the maintenance of that nation's high standards of living, the prevention of such losses and the husbanding of our forest capital are imperative. By means of present known improved practices and methods applied to wood products alone, two ninths of this loss could be prevented and the drain on our forest raw material would be lessened by approximately one and a half billion cubic feet, representing an annual saving of about 195 million dollars.

The elimination of this preventable waste in the woods, the mills and in service can best be brought about by the development of preventive methods through a study of the agencies causing these losses. As our methods of treating wood to prevent decay improve in proportion to our knowledge of the decay-producing fungi, so will our methods of preventing diseases in the forest improve as our knowledge of the disease-producing agencies increases.

Most foresters would place fire prevention first on the protection list, with insect control second and fungous diseases third. The more spectacular and more readily observed damage is usually impressed the deepest on the memory. While fire eats its way rapidly through a stand and in its wake leaves an annual loss of startling proportions, yet the control of fire is primarily concerned with keeping the loss at a minimum and, unlike certain tree diseases, there is little danger of the complete destruction of a species of valuable timber over its entire range. If, on the other hand, blister rust should gain the upper hand in the struggle for forest protection, our western white pine forests would virtually be doomed. Insect damage resembles, in many ways, the attack by fungi. With insect epidemics, however, we have balancing factors which bring the damage to a low ebb and frequently bring about almost normal conditions. On the other hand, we occasionally have a species of tree almost obliterated by an insect attack. The larch saw fly nearly wiped out the eastern larch in the Lake states some years ago, but in doing so it apparently sawed off the limb upon which it depended, for no recurrence of the epidemic is on record.

Fungous attacks are slow but steady in their advance upon our forests, and the effect is at times the least spectacular of all forest damages.

The Control of Disease in Trees and their Products

Fortunately, under present-day extensive forest management, the economically important forest tree diseases are not very numerous. As soon, however, as intensive forest practice becomes general and in step with the rapidly disappearing virgin stands, we will find the list increasing. Diseases which are of minor importance in our present timber stands may be found more harmful in the intensely managed forests of the future. There is also the possibility that changed conditions due to logging and to artificial control of the forest area in efforts to favor a maxi-

mum stocking of particular tree species may encourage the spread and development of some disease organism now obscure.

The prevention or reduction of the tremendous losses in the field of forest pathology and in the field of wood pathology is a difficult task, since forestry is yet in the extensive stage of its development.

The uniform and universal application of intensive control methods to the vast areas of timberland in the United States in an effort to ward off the more important tree diseases is beyond the limits of practicability under present economic conditions. The areas of inaccessible and low-value timber are too great, and even in the more accessible areas containing valuable timber the cost of an intensive job of control in many cases is prohibitive. We are, nevertheless, not justified in making a sweeping statement that the control of forest tree diseases is impracticable or impossible. The rapid depletion of our forests by fire, decay, disease and insects and through the steady and increasing toll of the annual cut will soon cause attention to be centered on the more accessible second-growth timber and potential forest areas. As wood becomes less plentiful, this reduction of forest capital will eventually call for a more intensive management of these forest areas and will result in the application of intensive rather than extensive control methods. At present, our faith in control methods leads us to hope that the damage due to the white pine blister rust in the West may be kept at a minimum by a system of local control concentrated upon the stream type where the most dangerous alternate hosts (susceptible wild currants or gooseberries) are found in greatest density. Beyond this we have ventured little or no distance in advocating intensive disease control over large areas of timber. The control of disease in a field, an orchard or in a woodlot is difficult enough, but when a heavily timbered area of several thousand acres, spread over very rough terrain, is contemplated, it is obvious that different methods are indicated for the two extremes.

The forester is faced with the triple problem of (1) preserving the present merchantable stand from further loss before harvesting; (2) providing for reproduction on all cut-over areas, and (3) the application of forest management to the stands of the future. In all three of these problems the question of protection against storm, fire, insect and disease demands an answer in practical terms. Control methods, therefore, are urgently needed to stem or check the tide of losses caused by tree diseases. Roughly, the control methods applicable in the practice of forest pathology may be classified as follows:

Exclusion—the use of quarantine and inspection measures to control the spread of diseases.

Eradication—the removal and destruction of alternate hosts or of diseased trees or parts.

Protection—sanitary measures, spraying, protective treatment, injections, etc.

Immunization—developing immunity by tree breeding, selection or other means.

Further divisions under each heading are, of course, indicated. In the control of white pine blister rust quarantine and inspection activities play their part along with eradication by means of pulling and uprooting the alternate host plants and the spraying of such plants with a killing chemical. Too frequently the difficulties confronting a control program of this kind in a terrain such as the Cocur d'Alene Mountains of northern Idaho are not fully realized by foresters and timber owners. To me it is startling, the progress that has been made in methods and efficiency of control, and in the rapid reduction of cost per acre. The splendid work is continuing, and we shall see in the near future the development of more effective chemical sprays and a greater reduction in cost of control.

Protection methods applicable to our present forestry practice are rather limited. Several sound principles, however, have been developed in the past few years mainly by western pathologists who strove to find methods which could be applied to the current practices. Pathological marking rules, sanitation clauses in timber sale contracts, disposal of infected slash on the logging areas and pathological cutting ages are all devices for reducing the spread of infection in our forests. I believe I am safe in stating that future forestry will pay more heed to the pathological type of cutting age as forestry intensifies.

The future control work in forest pathology, until intensive forestry arrives, will be confined mainly to the parasitic diseases such as the white pine blister rust, with special regard to measures of exclusion in an effort to prevent the introduction of new diseases. The control of heartrot diseases may in some cases rest on special methods of treatment, but as shorter cutting cycles become the rule and more and more products are made from young trees of small size, we will find that pathological cutting cycles will eventually eliminate a large amount of the heartrot losses. The crop of the future will be a cellulose crop, with short cutting ages and new methods of harvesting. The step from lumber to derived products and to synthetic products from pulp is not great, and the future will see lumber and other wood products manufactured from pulp obtained from small trees and young stands. A stand cut in its youth has developed little heartrot and no fungous fruiting bodies. It, therefore, leaves no great legacy of disease to the

oncoming stand and suffers itself but slightly from cull due to decay. But a stand cut in its later years carries with it an accumulation of heartrot and of fruiting bodies which in turn spread infection to the oncoming forest. In Idaho the decay factor is an important one in the management of hemlock and white fir on the cut-over areas and represents a problem which is closely knit with the future growth of white pine.

What shall we do with our residual hemlocks and white firs which at the time of removal of the white pine show from 30 to 100 per cent. infected with heartrot? If we leave them on the cut-over area they crowd out the white pine and so greatly reduce the yield at the next cutting. If left with the expectation of harvesting the hemlock and fir for pulpwood or other products, there is the depressing forecast that in the next forty or fifty years the heartrot will be so prevalent as to render the material useless. What then shall we do? Shall we practice girdling with all its attendant disappointments, high cost and fire hazard, or shall we invest in a type of insurance by cutting and burning all infected residual trees and thus give white pine a minimum of competition and an opportunity to yield a full stand of high-priced, sound wood at the next cutting? Studies have been inaugurated which we believe will throw some light on this problem and aid us in formulating a management plan which will insure a maximum yield of sound and valuable wood.

In wood pathology, which deals with the loss-producing defects caused mainly by fungi, we have two main types of control measures: prevention and eradication. Under these are various methods of dipping in chemicals, seasoning, storage and heat sterilization, with special applications to practically each type of wood product.

In this field the activity of control work will multiply and will intensify with each decade as wood becomes scarcer and more valuable. Much of the husbanding of our timber capital may be done by preventing waste in the use of wood. The product as well as the crop must be protected, and this fact emphasizes one of the most important fields of activity in forestry science.

A new angle in the field of wood utilization which has appeared of late on the pathological horizon may develop into an important means of saving much of our wood crop. It was not so very long ago that one would have been laughed at had he suggested the use of rotted wood in the manufacture of paper pulp —yet this is a commercial possibility and we find that the so-called white rots may be utilized in the manufacture of a fair grade of sulphite pulp. The brown rots are obviously unsuited for any such use on account of their color and weakened fibers.

There are additional methods which time and investigation may bring to the aid of the forester. The one is the use of wood-rotting fungi in converting waste wood to pulp or near pulp, while the other is the search for and development of wood-inhabiting fungi which possess the ability to change the artificial food upon which they are grown into commercially valuable chemical products. The first suggestion involves a search for the fungi which most readily convert wood to cellulose. Following this much work must be done to determine the optimum conditions of growth for the organisms and the development of such a process on a commercial scale.

The second suggestion is strengthened by a considerable background of present-day commercial processes in which micro-organisms, principally fungi, are used in the manufacture of valuable products. The manufacture of such products as alcohol, cheese, linen, taka-diastase, butanol, acetone, ethanol, acetic and lactic acids, gluconic acid and pectin are all brought about by the careful use of micro-organisms.

If, therefore, we can find ways to divert the fungi, which are destroying our wood capital, into some useful activity by harnessing their enzymatic power to a process of pulp production or to the manufacture of some useful chemical, then, truly, may it be said that our research is fulfilling its destiny.

The use of micro-organisms, particularly fungi, in industrial processes, presents at once many advantages and disadvantages. In general, such a use has the advantage of an even and smooth-running process, good yields with few impurities, minimum supervision and a low labor cost. When discovered, the use of a particular fungus to produce a certain substance which has previously required costly and complicated chemical equipment and reactions, or to produce a substance found only in nature, marks a decided step forward in coordinating the factors of chemical science with those of botanical science and in welding the two groups of data into a feasible commercial process. The disadvantages lie in the nature of the organism used and its sensitivity to conditions favoring its growth. Carefully controlled temperature, moisture, air and food conditions are essential, and this entails a carefully worked out process based on research in order to insure successful production.

In some such manner forest pathology may serve not only as a preventive and protective science, but may also find expression in the development of new and profitable ways of utilizing our waste wood.

DOCTORATES CONFERRED IN THE SCIENCES BY AMERICAN UNIVERSITIES, 1929-30[1]

By CLARENCE J. WEST and CALLIE HULL

THE Research Information Service of the National Research Council, with the cooperation of the registrars of the various American universities, has compiled annually since 1919–20 a classified list of theses of the recipients of the doctor's degree in the sciences. This list, together with those published in SCIENCE and in *School and Society* for the period 1898 to 1915, gives a complete picture of the doctorates granted since 1898, a period of over 30 years, the statistics for the period 1915 to 1919 having been collected by the Research Information Service in 1921.

TABLE I

DOCTORATES IN SCIENCE BY YEARS

1898	105	1909	194	1920	325
1899	105	1910	180	1921	336
1900	102	1911	239	1922	455
1901	127	1912	273	1923	575
1902	103	1913	234	1924	611
1903	134	1914	244	1925	640
1904	129	1915	314	1926	748
1905	143	1916	336	1927	796
1906	140	1917	372	1928	842
1907	143	1918	293	1929	1,025
1908	184	1919	180	1930	1,055

The total number of doctorates (11,472) granted in all subjects over that period is shown in Table I.

TABLE II

INCREASE IN DOCTORATES GRANTED BY LEADING UNIVERSITIES

	1900	1910	1920	1930	Total for 1898–1930
Chicago	19	24	43	94	1,367
Wisconsin	1	13	24	86	712
Cornell	11	27	35	80	986
Johns Hopkins	20	15	21	58	862
Michigan	1	1	9	53	407
Minnesota	1	1	4	53	310
Ohio State University	—	—	6	50	249
California	1	4	14	47	513
Columbia	12	11	25	44	945
Illinois	—	9	22	43	491
Yale	10	12	23	43	698
Harvard	15	10	28	40	735
Total for year	**102**	**180**	**325**	**1,055**	

[1] Compiled by Research Information Service, National Research Council.

In 1930 the number of doctorates granted was over ten times the number in 1900; in 1920 the ratio was 3:1, and in 1925, 6:1. The growth in this phase of graduate work is also seen in the number of institutions granting the doctor's degree. In 1900 there were 22 institutions represented in this compilation; in 1920, when the Research Information Service took over the work, the number had increased to 31, while the present compilation contains 62.

The increase in the number of doctorates granted in those universities, which in 1930 conferred 40 or more, is shown in Table II.

In 1900 there were 6 universities which granted 10 or more doctorates; in 1900 there were 9; in 1920, 10, and in 1930, 24.

The growth by subjects (only those in which 40 or more doctorates were granted in 1930 are listed) is shown in Table III.

TABLE III

INCREASE IN DOCTORATES BY SUBJECTS

	1900	1910	1920	1930	Total for period 1898–1930
Chemistry	26	48	134	309	3,685
Zoology	11	24	36	100	1,146
Psychology	9	20	26	92	1,059
Physics	15	25	28	89	1,180
Botany	12	10	29	81	1,097
Mathematics	11	23	16	74	800
Geology	5	10	11	63	612
Engineering	—	1	5	49	189
Physiology	4	4	8	46	423

During the period covered by this compilation, the same subject classification has been used in order that the statistics might have some comparative value, even though this means that many of the more recently recognized subdivisions of the major fields of science are not given a separate place in the classification. It has been deemed necessary, however, to add public health (in 1926) and medicine and surgery (in 1930), as scattering the theses on these subjects throughout the compilation gave no indication of the work in these fields.

It should be pointed out that in the classification of the following doctorates the compilers have had only the title of the thesis and, in most cases, the department in which the doctorate was granted. This has

often made it difficult properly to place certain theses and may account for the fact that a thesis appears under one subject when in reality it belongs under quite a different subject.

Detailed data for the year 1929–30 are shown in Tables IV and V. Full information with comparative statistics for the past ten years and with the names of the recipients of the degrees and the titles of the theses will be found in *Reprint and Circular Series* of the National Research Council, No. 95. Similar data for the years 1926 to 1929 are given in *Reprint and Circular Series* Nos. 75, 80, 86 and 91. Copies of these publications may be obtained from the Publication Office, National Research Council, Washington, D. C.

TABLE IV

DOCTORATES CONFERRED ACCORDING TO SUBJECTS

	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30
Chemistry	134	150	185	251	250	257	270	278	310	309
Zoology	37	39	45	42	71	55	70	89	91	100
Psychology	26	32	46	51	51	60	74	66	112	92
Physics	28	57	54	58	59	76	92	78	101	89
Botany	30	37	64	57	69	69	53	61	76	81
Mathematics	16	20	28	32	24	47	46	44	61	74
Geology	11	22	34	41	25	27	42	35	45	63
Engineering	3	4	5	5	2	11	10	28	34	49
Physiology	8	18	20	17	17	43	35	28	37	46
Pathology	1	27	21	12	5	4	16	31	27	31
Agriculture	3	9	10	11	16	19	19	31	27	29
Bacteriology	19	15	32	12	20	21	20	29	26	27
Geography	5	3	7	3	13	11	14	7	12	17
Anatomy	4	5	10	5	4	11	13	11	15	12
Public Health	...	...	...	...	...	3	4	4	15	8
Anthropology	4	0	3	3	2	5	3	5	13	6
Paleontology	0	1	2	2	1	7	0	1	2	6
Astronomy	5	4	6	7	3	7	9	3	8	4
Med. & Surg.	...	...	...	...	...	...	...	...	...	4
Metallurgy	2	1	2	2	3	10	4	13	8	3
Mineralogy	0	0	1	1	4	4	2	0	1	3
Archeology	0	0	0	0	0	0	0	0	2	2
Meteorology	0	2	0	0	0	0	0	0	2	0
Totals	336	455	575	611	640	748	796	842	1025	1055

TABLE V

DOCTORATES CONFERRED ACCORDING TO UNIVERSITIES

	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30
Chicago	42	61	71	75	59	78	86	70	99	94
Wisconsin	15	32	44	41	64	53	55	60	66	86
Cornell	33	36	41	60	39	43	62	67	60	80
Johns Hopkins	21	28	58	44	36	50	44	56	62	58
Michigan	7	20	15	25	15	32	30	52	38	55
Minnesota	16	16	17	23	23	30	29	41	53	53
Ohio State	8	13	21	20	33	25	30	25	48	50
California	22	24	27	20	31	38	42	37	50	47
Columbia	26	31	58	57	51	49	62	46	61	44
Illinois	19	28	33	20	32	44	31	36	34	43
Yale	27	22	34	22	41	38	34	38	47	43
Harvard	25	21	31	35	25	35	42	33	40	40
Mass. Inst.	7	8	11	18	18	13	18	13	20	29
Pennsylvania	5	9	8	12	12	14	27	18	24	26
Stanford	5	7	8	14	15	17	17	17	26	26
Iowa State Col.	...	...	...	9	12	14	13	26	28	26
Princeton	8	12	9	17	15	12	18	17	25	22
Calif. Inst.	0	2	0	9	8	15	8	18	22	18
Pittsburgh	2	7	7	5	8	7	11	13	8	15
Virginia	0	2	1	3	5	5	8	3	5	12
Clark	6	6	8	3	6	7	7	5	11	11
Indiana	1	3	5	5	8	7	5	8	9	11
Kansas	1	0	2	2	4	8	8	5	10	11
New York	4	3	10	2	5	7	4	11	13	10
Iowa Univ.	7	12	12	16	19	28	24	32	38	9
Brown	4	3	3	3	8	4	4	5	7	9
Northwestern	0	7	2	6	2	4	6	8	5	8
Wash. U., St. L.	3	2	8	2	0	5	7	2	7	7
Cincinnati	2	5	3	4	7	8	5	1	14	6
Fordham	0	2	2	0	2	2	1	2	8	6
Missouri	0	4	0	5	4	3	7	2	3	6
Nebraska	4	2	2	5	7	2	2	3	4	6
North Carolina	2	1	2	1	0	7	3	4	3	6
Texas	0	0	1	0	0	1	3	0	7	6
American	...	...	...	...	...	3	3	3	1	5
Radcliffe	3	3	3	2	3	3	2	1	2	5
Rutgers	...	...	...	...	...	2	3	9	4	5
Syracuse	1	1	0	0	0	2	3	2	1	5
Washington	0	2	0	1	3	1	1	5	8	5
Western Res.	...	...	...	...	...	...	...	...	3	5
Duke	...	...	...	...	...	...	...	...	4	4
Purdue	...	...	...	...	...	...	...	...	1	4
Maryland	1	0	0	1	5	6	3	6	8	3
Mass. Agric.	1	2	1	1	0	1	0	1	1	3
Notre Dame	0	0	1	2	0	0	0	0	1	3
Penn State	...	...	...	...	...	...	1	4	3	3
Rice	1	1	0	1	2	1	1	3	4	3
St. Louis	...	...	...	...	...	...	2	3	2	3
Boston	0	0	1	0	0	1	0	0	0	2
Bryn Mawr	2	7	0	1	1	2	4	0	1	2
Catholic	1	0	1	3	3	6	5	8	6	2
Colorado	0	1	1	0	1	3	1	3	3	2
George Wash.	2	8	18	5	6	4	4	2	5	2
Michigan State	0	0	0	0	1	4	2	2	6	2
Oregon	...	...	...	...	...	1	0	0	0	2
Rensselaer	2	1	0	2	0	2	2	7	3	2
Rochester	...	...	...	...	1	0	3	3	0	2
Wash. State	...	...	...	...	...	...	...	...	...	1
Tulane	...	...	...	...	...	...	1	2	1	1
Arizona	...	...	...	...	...	...	1	0	0	0
Georgetown	...	...	...	...	...	...	...	...	1	0
N. Y. Forestry	...	...	...	...	...	1	1	2	2	0
Marquette	...	...	...	...	...	...	...	1	0	0
Totals	336	455	575	611	640	748	796	842	1025	1055

SCIENTIFIC EVENTS

MEDICAL CENTER FOR URUGUAY

WE learn from the *Mental Hygiene Bulletin* that ground has been broken for the great medical center planned by the Comisión Honoraria del Hospital de Clínicas for Montevideo, Uruguay, the construction of which it is estimated will cost between $10,000,000 and $15,000,000. Approximately $5,000,000 has already been appropriated by the government to begin work on this project, the first of its kind in South America, which has the support of all elements in

the community, medical, educational, social, governmental and commercial.

Every effort will be made, according to the commission, the governmental body in charge of the project, to erect an institutional center for the care, treatment and study of the physically and mentally sick that will be the last word in modern hospitalization from the standpoint of scientific medicine and construction engineering. To this end the commission has drawn heavily upon professional and technical talent in the United States for advice and guidance.

Early this year Dr. Eduardo Blanco Acevedo, president of the commission, came to New York and consulted with Dr. C. C. Burlingame, chief executive officer of the group which built the Presbyterian Hospital-Columbia University Medical Center. This summer Dr. Burlingame was invited to Montevideo to consult with the commission and to study in detail its plans for the Medical Center which, apparently, was to follow in principle the New York Medical Center as a model project of this type.

Dr. Burlingame spent two months in Uruguay giving the authorities the benefit of his wide experience and expert knowledge in hospital planning, and making a number of recommendations as to organization and construction which were all adopted. Thanks to Dr. Burlingame, the needs of the mentally sick will have the same adequate attention under the scheme as those of the physically sick. In the plan adopted the psychiatric institute and hospital has been made an integral part of the medical center and is being designed, as to structure and function, along the lines of the New York State Psychiatric Institute and Hospital.

El Imparcial, one of the local newspapers which have been giving considerable attention to the project, remarked, in its discussion of the plans: "One of the items upon which Dr. Burlingame was most insistent in his conferences with the commission was the incorporation within the Medical Center of a Psychiatric Institute and Hospital, which he considered a vital part of the center and indispensable in any adequately conceived and comprehensive project of this type. Modern scientific medical opinion, Dr. Burlingame declared, considered such an institute as absolutely necessary not only to provide expert care for the patients suffering from mental disorders but to make possible research and educational work looking to the prevention of such disorders and the reduction of the great burden represented by the enormous amount of mental disease existing under present conditions of civilization."

According to the *Mental Hygiene Bulletin* the Psychiatric Institute and Hospital, which received the unanimous endorsement and enthusiastic support of the Psychiatric Society of Uruguay, will be built in close relationship with its sister hospital, the Neurological Institute, and will be equipped with clinical, research and diagnostic laboratories. Hospital beds will be so arranged as to make possible intensive study of any one of several types of mental disease. The whole institution will be organized around the four-fold function of treatment, research, teaching and public education. Special attention will be given to the teaching of all medical students in the fundamentals of psychiatry, and for the training of psychiatrists, mental nurses and psychiatric social workers.

THE TESTING LABORATORY OF THE BUREAU OF STANDARDS

According to the statement which was made public by the Department of Commerce, an increase of 27,214 in number of items tested at the Bureau of Standards during the fiscal year 1930 as compared with 1929 and a corresponding increase in fee value of $139,212 have been announced by Dr. George K. Burgess, director of the bureau. A comparison of figures for 1928 and 1930 shows increases for the latter year of 68,513 and $218,497. The total number of items tested during 1930 was 200,726 and the fee value $683,614.51.

These figures are particularly interesting at this time since they show a steady increase in the work of the government's largest testing laboratory during a period when business in general has decreased and when one would naturally have looked for a decided drop in general testing.

The bureau's statistics cover 46 different items or classes of tests. During 1930, as compared with 1929, there were increases registered under 26 of these items while in 20 cases the number of tests decreased. In the matter of fee value increases were noted in 28 cases, in two cases the fee value did not change, while in 16 cases the fee value decreased.

The greatest single increase of 1930 as compared with 1929 was in clinical thermometers where an increase of nearly 24,000 occurred during the year. (Total number tested, 100,648.) Large percentage increases were also recorded in electric batteries, miscellaneous dimensional determinations, aircraft engines, engineering materials, cement and ceramic materials. In comparing 1928 and 1930, important increases have taken place in electric batteries, electric lamps, dimensional determinations, weights and balances, volumetric apparatus, hydrometers, laboratory and clinical thermometers, radioactive materials, ceramic products and in the distribution of standard samples.

Roughly, two thirds of the bureau's test work is for

the national and state governments while one third is for the general public. Although the latter class of tests decreased about 14 per cent. in 1930 as compared with 1929 there was still an increase of 17 per cent. as compared with 1928. This is a very satisfactory showing and proves that the value of carefully conducted tests is becoming more generally appreciated.

BEAR RIVER MIGRATORY BIRD REFUGES

STATISTICS assembled by the Biological Survey of the Department of Agriculture covering the land status on the Bear River Migratory Bird Refuge in Utah, as of June 30, made public on September 20, show that the lands purchased total 15,860.65 acres; public lands withdrawn, 30,632.12 acres; state cession lands, 2,132.85 acres; lands leased, 7,860.98 acres, and right-of-way easement, 0.14 acre; or a total of 56,486.74 acres. When withdrawal lands exchanged, amounting to 4,099.8 acres, are deducted, the net refuge area is 52,386.94 acres. During the fiscal year 1930 there was expended for lands $24,547.28; other expenditures for acquisition purposes amounted to $307.41, making a total of $24,854.69. The average cost an acre for lands purchased was $1.55.

Of the 163,468 acres within the boundary of the Upper Mississippi River Wild Life and Fish Refuge, 19,162 acres are reported as agricultural and semi-agricultural lands, 20,000 acres as unsuited for purchase, 9,743 acres as state and city owned, 25,018 acres as public domain (made part of refuge by executive orders), 1,650 acres as acquired by gifts and cessions, 8,777 acres under contract, and 56,548 acres actually paid for, leaving 22,570 acres to be taken under contract.

The cost of examining and appraising 225,000 acres was $22,500, or 10 cents an acre. This calculation is based on land area examined and takes no account of approximately 70,000 acres of interlocking waters that were covered by examinations. For making boundary surveys $10,939 has been expended, and $40,393.46 for negotiating for 65,325 acres under contract or acquired, or an average of 62 cents an acre. This figure is based on the tracts covered by contracts, although all the tracts within the refuge have been negotiated for. The average cost of lands taken under contract is $6.29 an acre, and the average cost of lands paid for is $6.06 an acre.

Lands to be acquired for the Cheyenne Bottoms Migratory Bird Refuge, near Great Bend, Kansas, the creation of which was authorized by act of Congress approved on June 12, are being surveyed by field crews of the Biological Survey. When the government gains control of the lands needed for the purpose, the refuge established will be of outstanding importance to the birds migrating in the Mississippi Valley region.

Topographic surveys of other proposed refuge areas are being conducted and engineering facts gathered with dispatch. Part of the information being obtained is to enable the Biological Survey to determine what may be done toward establishing migratory-bird refuges in regions where it may be possible to restore areas now desolate to their natural condition.

These refuges are being established in furtherance of the terms of the migratory bird conservation act, to preserve the birds of the United States and Canada protected by treaty with Great Britain.

MEMORIAL TO GEORGE WESTINGHOUSE

NATIONAL, state and city officials and executives of public utilities, industrial concerns and banks have dedicated in Schenley Park, Pittsburgh, a monument to George Westinghouse, inventor of the air brake and other railway devices, the automatic telephone exchange, the jet steam turbine, a piping system for natural gas and organizer of alternating current electric systems in the United States.

The memorial is the tribute of 50,000 workmen and professional men, members of the Westinghouse forces living under many flags. More than three hundred prominent men accepted invitations to the ceremony. The site of the monument is near a small pond in a grove of willow trees.

Henry Hornbostel, designer of the Harding Memorial at Marion, Ohio, the Hell Gate Bridge and other structures, designed the Westinghouse Memorial in association with Eric Fisher Wood. Daniel Chester French, sculptor, executed the main sections in war under Mr. Hornbostel's guidance and Paul Fjelde produced the panels representing Westinghouse's six chief mechanical achievements.

The base is of Norwegian granite, which also is inserted into the bronze upper portions. The rest of the monument is of bronze, gold-leafed. The center or main section shows a medallion of Westinghouse between an engineer and a skilled mechanic. Facing this semi-circular construction is a figure representing American youth taking inspiration from the inventor.

Among those present were Lord Southborough, of Great Britain; H. G. Brown, deputy chairman of the Westinghouse Air Brake and Saxby Signal Company, Ltd., of London; R. G. Gage, chief engineer of the Canadian National Railways, and P. J. Myler, president of the Canadian Westinghouse Company.

Herman Westinghouse Fletcher, grandnephew of George Westinghouse, unveiled the memorial, which was presented to Pittsburgh by George Munro, veteran Westinghouse employee, and accepted by Mayor Charles H. Kline.

SCIENTIFIC NOTES AND NEWS

The William Lawrence Saunders Gold Medal for 1930, awarded annually for achievement in mining by the American Institute of Mining and Metallurgical Engineers, will be presented to Mr. Daniel C. Jackling, of San Francisco, president of the Utah Copper Company and other mining corporations, at a dinner on October 31 at the Ritz-Carlton Hotel in New York City. President Hoover was the recipient of the Saunders medal for 1928.

Dr. Michael I. Pupin, professor of electro-mechanics at Columbia University, has received the decoration of the White Eagle of the First Order, conferred upon him by Alexander I of Jugoslavia for outstanding service to the nation.

Guglielmo Marconi has been elected president of the Italian Royal Academy, succeeding Senator Tomaso Tittoni, who resigned for reasons of health. Senator Marconi thus far had not been a member of the academy. Premier Mussolini, however, obtained King Victor Emmanuel's signature to decrees making the inventor both an academician and president of the body.

At a special convocation of the faculty of the University of Chile, Dr. Roscoe W. Thatcher, president of the Massachusetts Agricultural College at Amherst, was last summer made an honorary member of the faculty and was awarded an honorary doctorate by the Catholic University of Chile at Santiago.

Mr. Felix M. Warburg, vice-president of the Museums of the Peaceful Arts in New York, is the recipient of the golden ring of the Deutsches Museum presented by the Government of Bavaria. It was presented to him by Dr. G. Heuser, acting consul general at New York City. Mr. Warburg has been actively interested in the Deutsches Museum and also in the development of industrial museums in America, particularly in the New York institution.

Dr. Thomas S. Cullen, professor of clinical gynecology in the Johns Hopkins University School of Medicine, was presented with the degree of doctor of laws by the University of Toronto at a special convocation on September 16, in connection with the opening of the Banting Research Institute. The honor was conferred in recognition of Dr. Cullen's work on cancer. He graduated from the University of Toronto forty years ago.

The Founder's Day address at Lehigh University was delivered by Dr. Edward Wilber Berry, dean of the Johns Hopkins University, on October 2. He spoke on "The Nature of Progress." Honorary degrees were conferred on Professor Berry and on Harald Malcolm Westergaard, professor of structural engineering at the University of Illinois.

Portraits of Dr. George L. Brown, dean of the faculty and of the division of general science of State College, and of Dr. Hubert B. Mathews, vice-dean of the faculty and for many years professor of physics, will soon be hung in the Lincoln Memorial Library of the South Dakota State College. The portraits were painted by Harvey Dunn, of New York, a former student at the college.

Dr. Ivan M. Johnston, of the Gray Herbarium of Harvard University, has been elected a corresponding member of the Argentine Society of Natural Sciences.

Dr. J. C. Th. Uphof, professor of botany at Rollins College, has been elected a corresponding member of the Deutsche Dendrologische Gesellschaft in recognition of his researches in the dendrology of the State of Florida.

Dr. Elmer Drew Merrill, as director of the New York Botanical Garden, has been appointed a professor of botany at Columbia University.

Changes in the department of chemistry of New York University include the appointment of Dr. A. O. Gettler as professor and J. K. W. Macalpine and W. West as assistant professors. Dr. Hilde Thurnwald, lately assistant to Professor G. F. Hüttig at the Deutsche Technische Hochschule, Prague, is spending the year at the university as a fellow of the Rockefeller Foundation.

Dr. Harlan T. Stetson, director of the Perkins Observatory of Ohio Wesleyan University, reports that the following appointments have been made as additions to the staff: Dr. N. T. Bobrovnikoff, formerly of the Lick Observatory and National Research Fellow at the University of California, assistant professor of astrophysics; Dr. N. Wyman Storer, formerly of Wesleyan University, assistant professor of astronomy, and Mr. Marvin E. Cobb, Drake University, fellow in astronomy.

Mr. Edw. H. Graham, formerly herbarium assistant, has been appointed assistant curator of the section of botany at the Carnegie Museum, Pittsburgh.

Dr. H. M. Martin, formerly associate professor of animal pathology and hygiene at the University of Nebraska, has become parasitologist in the Pennsylvania Bureau of Animal Industry Laboratory, Harrisburg, Pennsylvania.

THE Roessler and Hasslacher Chemical Company, Incorporated, announces the following changes and appointments: Dr. W. F. Zimmerli, who has been with the commercial development division at the New York office, has been appointed head of the same department at Niagara Falls. New appointments to the technical staff at the Niagara Falls plant include: Noah S. Davis, Jr., Ph.D. (Yale, 1930); Alton Gabriel, Ph.D. (Cornell, 1930); H. E. Klein, Ch.E. (Purdue, 1930); Lloyd Mann, B.S. (Middlebury, 1930); H. A. McPhail, M.S. (Toronto, 1930); W. T. Rinehart, M.A. (Indiana); W. B. Tanner, Ph.D. (Iowa State, 1930); Jane Williams, B.A. (Indiana, 1930). Dr. J. H. Payne, of the Niagara Falls plant, has been assigned a year's leave of absence to complete studies in Germany.

DR. C. V. TAYLOR, of Stanford University, is visiting professor of zoology at the University of Chicago.

THE National Research Council has made a grant of $500 through the division of chemistry and chemical technology of Emory University to further the work of Dr. J. L. McGhee on the regeneration of hemoglobin in rat and man.

DR. JOHN B. NANNINGA, a graduate of Rush Medical School, has been appointed fellow in research at the University of Kansas School of Medicine, under Dr. Ralph H. Major. His fellowship was made available by the committee of scientific research of the American Medical Association and the National Research Council. It is to be devoted to the study of depressor substances.

DR. HELEN M. GILKEY, associate professor and curator of the herbarium at the Oregon State Agricultural College, being on leave of absence, has joined the staff of the Gray Herbarium of Harvard University for the academic year 1930–31.

PROFESSOR R. A. WARDLE, of the department of zoology of the University of Manitoba, spent the summer studying tapeworms in salmon at the Pacific Biological Station, Nanaimo, B. C., and Professor V. W. Jackson, of the department of biology, in studying the flatfish of the Pacific coast.

DR. R. G. GUSTAVSON, professor of chemistry at the University of Denver, has returned to his work after a year's leave of absence during which he taught and engaged in research work at the University of Chicago. Professor Gustavson will continue at Denver his experiments with the sex hormone.

DR. WALTER R. KIRNER, assistant professor of organic chemistry at the Rice Institute, Houston, Texas, has returned from a sabbatical year spent in study in Europe. During the year he worked at the University of Graz in Austria, studying the technique of micro-organic analysis under Professor Fritz Pregl. The complete apparatus for organic micro-analysis has been purchased for the Rice Institute. Dr. Kirner also spent five months doing research in Professor Heinrich Wieland's laboratory in the University of Munich and five months with Professor Robert Robinson at the University College of London.

E. B. RENAUD, professor of anthropology at the University of Denver, has returned from the first archeological survey of eastern Colorado. Accompanied by student assistants, Dr. Renaud explored the region between the mountains and the Kansas state line, bringing back nearly a ton of relics which are now being worked over and classified. The trip was financed jointly by the Smithsonian Institution, the Colorado Museum of Natural History and the University of Denver.

DR. BAINI PRASHAD, director of the Zoological Survey of India, Indian Museum, Calcutta, is visiting museums of the United States.

DR. FRANK P. GRAHAM, newly elected president of the University of North Carolina, delivered the final address at the meeting of the North Carolina Forestry Association on September 27. He discussed the relation of education to forestry.

DR. ROBERT FRANK, Mount Sinai Hospital, New York City, will deliver the first Harvey Society Lecture at the New York Academy of Medicine, on Thursday evening, October 16. His subject will be "The Female Sex Hormone."

AT Wesleyan University, the first lecture of the year of the Middletown Scientific Association will be given on Friday, October 17, by Professor Frederick K. Morris, of the Massachusetts Institute of Technology, on "The New Meaning of Exploration." Professor Morris was a member of the expedition from the American Museum of Natural History of New York to Central Asia. He will tell of modern methods of exploration and will illustrate them with accounts from his own experiences in the interior of China and Mongolia.

THROUGH a misunderstanding, Dr. Ralph R. Mellon was given as one of the authors of the article in SCIENCE for August 15 entitled "An Effect of Short Electric Waves on Diphtheria Toxin Independent of the Heat Factor," by Dr. Waclaw T. Szymanowski and Robert Alan Hicks. Dr. Mellon is director of the laboratory in which the work was done.

APPLICATIONS for metallurgist must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than October 29, 1930. The entrance salary is $3,800 a year. This examination is to fill

vacancies in the departmental service, Washington, D. C., and in the federal classified service throughout the United States. Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience and fitness, and on publications, reports or a thesis.

Mr. Henry Ford has contributed $250,000 to the Deutsches Museum at Munich.

Through efforts of the Florida Audubon Society, the ornithological library of the late Dr. Henry Nehrling, horticulturist and ornithologist, has been acquired for Rollins College. The society loaned a portion of the purchase price and thus preserved for the college a collection said to be unique in many ways.

The American Society for the Control of Cancer plans to publish on January 1 the first issue of *The American Journal of Cancer*, under the editorship of Dr. Francis Carter Wood, of the Crocker Institute of Cancer Research.

The Christian Science Monitor reports that a discovery of land in the inland ice of Greenland has been made by Dr. Lange Koch, who has returned to Copenhagen from his fourth expedition to that country. With Dr. Koch were the other members of the expedition, Professor Helge Backlund, Swedish geologist; two Danish students of natural history, a geologist and a botanist, who joined them in Greenland. The discovery was made along the eastern coast of Greenland, in the same latitude as the Umanok district by Professor Backlund, who had been sent out with a special section. Dr. Koch, however, through a series of investigations as early as 1929, had reached the conclusion that there must be land in the inland-ice in the form of islands. These were first seen during an ascent of the Jordan Hill.

The Museum of Science and Industry (Museums of the Peaceful Arts) of New York City is projecting an extensive exhibition covering all the scientific and technical phases of color. The color exhibition will begin shortly after the first of January and will continue for two months. Dr. F. C. Brown, formerly assistant director of the U. S. Bureau of Standards, is director of the museum; Mr. I. G. Priest, chief of the colorimetry section of the Bureau of Standards, is chairman of the advisory committee, which includes most of the names best known in the field of color, and Dr. I. H. Godlove, formerly of the Munsell Color Company, is in charge of arrangements for the color exhibition. A number of the large industrial corporations have signified their intention of exhibiting color measuring and related apparatus. In addition, a number of special educational features, lectures, etc., are being planned.

The U. S. Public Health Service will be enabled to begin its cancer survey of the United States at once due to the insertion of a $100,000 item in the Second Deficiency bill. The survey will include: (1) An investigation of the researches being carried on with respect to control of cancer in various institutions in the United States and abroad. (2) An investigation of existing methods of treatment of cancer with view to determining and encouraging use of best methods of treatment to the exclusion of those that are worthless or fraudulent. (3) The ascertaining of best methods of increasing the number of physicians skilled in the diagnosis and treatment of cancer. (4) The ascertaining of best means of educating the public with respect to the signs and symptoms of cancer in early stages in order to prevent neglect and delay in treatment. (5) The ascertaining of the extent to which provision now exists for furnishing optimum treatment for cancer for all sufferers, together with estimate of what would be needed to make this adequate and the cost thereof. (6) The collection of any other pertinent data to enable Congress to act advisedly in this matter.

Under the direction of Dr. Arthur L. Day, director of the geophysical laboratory of the Carnegie Institution, a well is being drilled at Norris Geyser basin in an attempt to find out at what depth the heat is located that causes geysers. A well was put down a year ago at the Old Faithful basin, extending to a depth of 406 feet, striking a temperature of 170 degrees Centigrade, or about 338 degrees Fahrenheit. Dr. Day directed this work. In this experiment, according to a statement made by Dr. Day to the *U. S. Daily*, the drill was pushed first through geyserite and then through glacial gravel, then more geyserite, indicating that the glacier was working in this territory before the ice age. In the experiment being conducted in the Norris basin, it is hoped to put the drill down until such heat and steam pressure is encountered as will prevent further drilling. It will be impossible to go through to molten rock, but it will be possible to judge by the distance and the increased temperature the approximate distance of lava.

The Cumberland Power Company has rejected an offer from the Commonwealth of Kentucky of $230,000 for land owned and for options on other land on which Cumberland Falls are located, and the Commonwealth will proceed with condemnation suits, according to an announcement by the attorney general, J. W. Cammack. Refusal of the offer, the attorney general said, was made in a letter replying to his offer to purchase five tracts of land owned by the power company, for $210,000, and to pay $20,000 for

an assignment of all options held by the company on the Brunson property, the site of the falls. Upon receipt of the rejection of his offer, Mr. Cammack stated that papers in a condemnation suit are being prepared and will be filed at an early date, seeking to condemn Cumberland Falls and the acreage owned by the power company for state park purposes. The offer to the power company, he explained, was made under an act of the 1930 legislature accepting an offer of Mr. T. Coleman du Pont to donate $230,000 to acquire the falls for a state park.

FROM Science Service we learn that a series of gorgeous waterfalls never before seen by a European and practically unknown to natives have been discovered in South Africa by Farquhar B. Macrae, of the Northern Rhodesian Civil Service, and described by him in a report to the Royal Geographical Society. One of the falls is 200 feet in height, or 33 feet higher than the Niagara Falls, and rivals in beauty the famous Victoria Falls which are about twenty miles distant. This fall is, however, only one of a series following each other in rapid succession so that the total effect is that of a much greater drop totaling 334 feet. They are known to the natives as the Chiengkwasi Falls and are on the Chunga River which empties into the Zambezi. It is on the Zambezi River that the Victoria Falls are located. In describing the Chiengkwasi, Mr. Macrae says: "The main Chiengkwasi fall is a fine sight. Numerous very green ferns grow in holes and cracks in the stone and the water dashes down over the smooth face of the rock, spurting out in little plumes of spray wherever it meets an obstacle. In times of flood it must be an awe-inspiring sight during the few hours that such a short river would remain at its maximum height." A few miles from the Chiengkwasi Mr. Macrae found another impressive series of five falls. The largest of these was a drop of 83 feet. "Below this fall the scenery is most imposing. Towering basalt precipices rise on either side of the river, which is never much more than 100 feet broad and is generally considerably narrower. At one point the cliffs can not well be less than 400 feet high and are probably higher. They rise in a sheer wall from the water's edge. The general impression of height is greater than that conveyed to an observer standing at the bottom of the Palm Grove at the Victoria Falls."

ACCORDING to the French correspondent of the *Journal* of the American Medical Association a recent report shows that the new branch of the Pasteur Institute established some time ago, at Kindia, French Guinea, is developing in an excellent manner. The branch was created after long and patient effort. Professor Calmette in 1913 decided to establish the branch but the outbreak of the war postponed the plan. Originally the idea was to create merely a station for the collection of anthropoid apes destined for shipment to France for laboratory experiments and for a close inspection of the apes before transporting them, for in the past many animals have arrived in Europe in a tuberculous state. After the war the project was taken up, and the government of French West Africa offered 35 hectares of land in a healthful region, 7 kilometers from Kindia, which is located 150 kilometers from the coast, on the railway running from Konakri to the Niger. Since that time a number of buildings have been erected. The central building comprises the laboratory and the lodgings of the director and of transient guests. There are animal quarters, cabins for the native employees and a factory with electrically driven machinery. Eighteen hectares are under cultivation to produce food for the men and the animals. Apes of all kinds are captured and given quarters at Kindia, some for experimentation on the ground, and others for transport in sound condition to the Pasteur Institute in Paris. The laboratory, utilizing cattle and small animals, prepares various serums, among others the antiplague serum. Studies are carried on in connection with antituberculosis vaccination in apes, the inoculation of apes with human malaria and its treatment, the artificial production of cancer (thus far, without results), the spirochetoses of the ape, pneumococcosis, rabies and anthrax. This laboratory has the advantage of having for experimentation animals living in their native habitat, protected against the diseases that beset them in the laboratories of Europe. The directing personnel consists of Colonel Wilbert, veterinarian; an assistant director, and a physician of the colonial forces. There are from seventy to eighty native employees.

DISCUSSION

SALINE DRINKING WATER AND ABNORMAL LIVESTOCK

IN the May 30, 1930, issue of SCIENCE, Ira S. Allison attributes the poor development and abnormal condition of the livestock in western Minnesota to the high sulphate content of the water in this region. Dr. Allison is entirely correct in his statements regarding the condition of the livestock and the general correlation of this fact with excessive sulphates in the water, but his conclusion that this relationship is one of cause and effect is not borne out by numerous

facts. We have shown[1] both under practical and experimental conditions that the trouble is primarily one of phosphorus deficiency. We have demonstrated that it can be entirely prevented and completely cured by the continuous use of sufficient phosphate supplement in the ration. Apparently worthless cattle have become valuable producers after their cure. Limestone has practically no value in alleviating the conditions because it is rare to find animals in this region suffering from calcium deficiency. Bone meal, wheat bran, cottonseed meal and other feeds are effective because of their high phosphorus content. These facts are supported by the observations of Alway,[2] who finds that "phosphate hunger of the soils is very common and wide-spread" in the same region.

We do not wish to give the impression that the sulphate content of the water is of no importance in the difficulties mentioned. Ever since our investigation of this problem began in 1923 we have been trying to determine to what extent the excessive amount of magnesium sulphate in many samples of water in the affected region is a factor in augmenting the poor condition of the livestock. Although it was very clear from our first studies that this could not be the major factor, we have obtained some experimental evidence that magnesium sulphate may at times be of minor importance. However, the phosphorus deficiency overshadows it so greatly that we are no longer concerned with the water as a major contributing factor.

Readers who are not familiar with this problem may be interested to know that the regions of phosphorus-deficient soil and correspondingly poor livestock are not confined to Minnesota, North Dakota and Montana, mentioned by Dr. Allison. Similar conditions have been reported on the coastal plain of Texas, on both the Wisconsin and Michigan sides of Lake Michigan and in limited areas in New York. There is some evidence that the trouble occurs in the irrigated section of the Southwest and intermountain region. It is also rather common in other parts of the world—in Europe, Africa, Australia and New Zealand. The investigations of phosphorus deficiency in South Africa by Theiler[3] are the only ones comparable in extensiveness to our own studies in Minnesota.

The economic condition of many of the farmers in the affected regions of Minnesota is pitiable. The seriousness of the situation becomes apparent when it is realized that these people have no surplus cash income with which to start alleviating their plight through the purchase of fertilizers or proper feed supplements rich in phosphorus.

L. S. Palmer
C. H. Eckles
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Agricultural Experiment Station

AGE OF THE HOUNSFIELD BENTONITE

The Hounsfield bentonite, here defined, has its type section in the small quarry just north of the Dexter-Brownville road two miles east of the town of Dexter, Jefferson County, New York; the township of Hounsfield is a mile south of the locality. In the quarry it occurs as a bed of gray-white, homogeneous clay reaching three eighths inch in thickness lying above the Leray limestone and below the Watertown limestone in the Chaumont formation of Ordovician, upper Black River age. In Ontario the Hounsfield occurs within the intermediate Glenburnie member of the Chaumont near Kingston and in the Coboconk limestone of the Lake Simcoe district; in the upper Mississippi Valley it is found consistently within two feet of the base of the Spechts Ferry member of the Decorah formation; the presence of the bed has been reported in Minnesota and Tennessee.

The fact that the Hounsfield bentonite has been found to occupy the position that it has in the type Black River section establishes a new basis for the correlating of beds in other regions within which the bentonite occurs with those in the type section.

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REGULATION OF BODY TEMPERATURE IN OPOSSUMS OF THE GENUS MARMOSA

Recently in Science (April 25, 1930) under the title "Banana Stowaways Again," Robert K. Enders records another instance of the small marsupial, genus Marmosa, coming into this country with bananas from Central America. Since they are supposed to feed only on ripe bananas he is perplexed at their ability to withstand such a long journey without food, only green bananas being available, and in a temperature much lower (57° F.) than they are accustomed to in their native habitat.

It has occurred to me that possibly the explanation may be the very fact that they were kept in "cold storage" with a constant temperature of 57° F. during

[1] C. H. Eckles, R. B. Becker and L. S. Palmer, "A Mineral Deficiency in the Rations of Dairy Cattle," Minn. Agr. Exp. Station Bull. 229, 1926; L. S. Palmer and C. H. Eckles, "Effect of Phosphorus Deficient Rations on Blood Composition in Cattle," *Proc. Soc. Exp. Biol. Med.*, 24: 307, 1927; L. S. Palmer, C. H. Eckles and D. J. Schutte, "Magnesium Sulfate as a Factor in Retention of Calcium and Phosphorus in Cattle," *Proc. Soc. Exp. Biol. Med.*, 26: 58, 1928.

[2] F. J. Alway, W. M. Shaw and W. J. Methley, "Phosphoric-acid Content of Crops Grown upon Peat Soils as the Index of the Fertilization Received or Required," *J. Agr. Res.*, 33: 707, 1926.

[3] A. Theiler, "The Cause and Prevention of Lamziekte," *J. Dept. Agr.* (Union S. Africa), 1: 221, 1920.

the voyage to New York City and also during the seven days' trip from there to Albany.

It is known that the capacity for temperature regulation is imperfect in the lower mammals as the monotremes and marsupials. Sutherland reports the temperature of the wombat to be 34.1° C. Martin also suggests that the power of marsupials to regulate body temperature is less than that of higher mammals.

Might it not be possible that these small opossums of the genus Marmosa, kept in a subnormal temperature, were unable to maintain their body temperature and became lethargic or partially so with the consequent reduction of metabolic activities? Under such conditions no food taking would occur and with the metabolic rate greatly lowered the animals could survive extended periods of adversity. This would be still more plausible for the immature individuals as the young of many mammals do not have the regulation of body temperature well established at first.

It would be extremely interesting to make some observations on the variations in body temperature of this particular genus of opossums and also to find out their behavior when placed in an environment with the temperature as low as 57° F. It happens that this temperature approaches very closely to the ideal hibernating temperature of mammals exhibiting this phenomenon, with which I have had some experience.

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University of Nebraska

CONCERNING OWL ATTACKS

In a note in Science for November 1, 1929, attention was called to the attacking of persons in Morgantown, West Virginia, by screech-owls, and a vague inquiry was made as to whether others had had a similar experience.

It was not long before the inquiry was answered so emphatically as to leave no doubt as to the fairly common occurrence of this experience.

Several answers appeared in forthcoming issues of Science, and the author received personal letters from more than a dozen individuals scattered from Oregon and Texas to Ontario, Canada. Several of the writers were college professors, two were physicians, one was an eminent chemist, one was apparently a lumberman and the occupations of the others could not be determined from their letters.

Several mentioned specifically the screech-owl as the attacking bird; one said the attack was by a great horned owl; one bird was apparently the snowy owl, and a few writers did not name the owl.

In most cases the attack was at dusk, though one was at dawn and one on a moonlight night.

Five of the writers said the owls had nests or young near by, and gave that as the cause of the attack. One writer thought the owl mistook the hair on the head of the person attacked for some mammal on which it preyed.

Several persons said that the owl swooped down close to the head, snapping its beak but not actually touching the one attacked.

A majority of the correspondents reported the victim struck with claws or beak and sometimes painfully injured. In one case a lumber-jack was said to have "carried a sore neck for a number of months." In another case a Louisiana Negro lost an eye by the attack of an owl.

In a certain part of one town policemen were much annoyed by the attacks of owls.

The following list will show the wide distribution of the persons reporting these owl attacks:

C. F. Adams, M.D., Indianapolis, Indiana; W. B. Anderson, Corvallis, Oregon; Hugh Bahlert, Pound, Wisconsin; W. W. Chapman, Mississippi; Watt Chung, New York; W. P. Flint, Illinois; L. S. Frierson, Shreveport, Louisiana; Forry R. Getz, Forest Hills, New Jersey; Arthur Goshorn, Winterset, Iowa; M. S. Green, New York City; R. T. Hall, American Museum of Natural History; H. Hapeman, M.D., Minden, Nebraska; Dr. A. G. Ingalls, Seneca Lake, New York; Chas. Macnamara, Arnprior, Ontario; G. W. Martin, Iowa City, Iowa; L. S. Owens, Lebanon, Ohio; Chas. L. Reese, Wilmington, Delaware; Maurice Ricker, Woodside, New York; Thos. B. Rogers, Orange, New Jersey; Clarence E. Shaner, Westminster, Maryland; A. Sion, Kyle, Texas; O. M. Smith, Stillwater, Oklahoma; T. C. Stephens, Sioux City, Iowa.

Albert M. Reese
West Virginia University

HOMO SAPIENS, VAR. CHICAGOIENSIS

The following excerpt from *Variety*, the theatrical trade paper, of July 30, may be of interest to the readers of Science:

What Chi Goes For

Chicago, June 29.

Astrology fortune telling joints are popping up along Michigan avenue.

All are getting a terrific play. Fad started with the opening of the Adler Planetarium on the lake front in Grant Park a few weeks ago. Star peeking house is now drawing 3,000 a day, with about half the number, as soon as they hit the boulevard again, hot-footing it to the star mitt readers, who are charging from \$1 to \$10 for connecting up the stars the folks saw with their destiny.

Play has become so strong local picture house chain is working desperately on a plan to bring some of the star gazers into the lobbies of their nearby houses, where it is planned to spot star teller.

Ramsay Spillman

QUOTATIONS

THE BRITISH ASSOCIATION AT BRISTOL

MEMBERS of the British Association must be grateful for the warmth of the reception and for the excellence of the arrangements made by the local committee for the meeting at Bristol, which ended yesterday. Visitors from many provincial universities saw with an admiring envy the splendor of the new university buildings, due largely to the munificence of the leaders of a local industry which has not ended in smoke. The great assistance given by the members of the family of Wills to the transformation of what was recently an unimportant college into a fully-equipped university shows that some commercial magnates understand the point made by Dr. Bower in his presidential address as to the value to industry of pure research. It is significant that one of the most admired contributions to the scientific proceedings which received the congratulations of Sir Ernest Rutherford and Sir Oliver Lodge, was made by Dr. J. E. Lennard-Jones, a young professor of the University of Bristol, not yet, but doubtless soon to be, a Fellow of the Royal Society. The idle might ask to be told the value of Dr. Lennard-Jones's efforts to track the gyrations of electrons when some of these can be described only in a space of six dimensions, and when the electrons themselves are bodies, or ideas, so elusive that no single one can be identified or followed. Or what is to be said of the discovery announced by Sir Ernest Rutherford himself, that by a new method now in use at the Cavendish Laboratory the stream of alpha particles emitted by certain excited elements is a complex composed of subsidiary streams moving with different velocities? Or what value are we to assign to the large number of technical papers which occupied most of the time of the Sections, although even their titles conveyed nothing to the uninitiated? Let it be said in passing that one of the features of the Bristol meeting, impossible to reproduce in a general newspaper, was the scientific value of the detailed papers which were read. As is almost inevitable, there were contributions which, from their subject, or title, or from some extraneous attachment achieved a publicity beyond their intrinsic merits. But these were exceptions. The great part of the proceedings, except the presidential addresses, which in most cases were wisely adapted to less specialized listeners or readers, consisted of genuine contributions to knowledge, directed only to experts and with no plain bearing on practical affairs. What of them?

A clue may be found in the animated discussion held by the chemists on the past history, present position, and future prospects of the dyestuffs industry. There was what may be called the Woad epoch of dyes which lasted until little more than half a century ago. The colors used in textiles and many other industries were natural products coming from plants or animals or minerals. It is an old story with a modern lesson that the scientific curiosity of Perkins, an Englishman, led to the building up, from the waste products of the distillation of coal, of artificial dyes more brilliant than Tyrian purple, more lasting than saffron and indigo, and without limit in their shades and tones. The discovery of synthetic dyes, this by-product of pure research, led, although not in this country, to the founding of an industry invaluable to the world not only for its primary output but also from the circumstance that it has required, created, and supported an army of research chemists. The labors of these men enabled Germany not only to secure almost a monopoly of the production of dyestuffs, but also to take the lead in the discovery and marketing of synthetic drugs, and, in the hour of her need, to thwart the endeavours of the Allies to deprive her of munitions of war. This is not the place to read the fiscal lesson as to how far British apathy in the past has been redeemed by the partial protection of a basal industry, or to discuss the necessity, urged by a great majority of the experts in the Chemical Section, of a further extension of the Dyestuffs (Import Regulation) Act, 1920. But the scientific lesson is plain. In the modern world a nation can not expect to hold its own, unless it encourages in the fullest way fundamental, unoriented research into the arcana of Nature, and unless it is alert to take immediate advantage of every practical outcrop of such research. The activities of the British Association for the Advancement of Science are to be welcomed, therefore, in the first place because they bring specialists together in conspiracy for the progress of knowledge, even if their deliberations be in terms and on subjects beyond the comprehension of laymen; and next because they give an annual opportunity to science to explain the intrinsic interest of the exploration of Nature and the vast practical boons that have come in the past, and may come at any moment. As it appears that more funds are required to stabilize the organization of the Association, all will wish success to the Centenary Fund for which the Council is asking.—*The London Times.*

SCIENTIFIC BOOKS

The Biological Control of Insect and Plant Pests; A Report on the Organization and Progress of the Farnham Laboratory. By W. R. THOMPSON. His Majesty's Stationery Office, London. 124 pp., 8 plates. Royal octavo. E. M. B. 29.

The Cocoanut Moth in Fiji: A History of its Control by Means of Parasites. By J. D. TOTHILL, T. H. C. TAYLOR and R. W. PAINE. Imperial Bureau of Entomology, London, published for the Government of Fiji. vi + 269 pp., xxxiv plates, 119 text figs. Imperial octavo.

AMONG the very many useful and important things that the Empire Marketing Board has done for the British Empire, its support of the Imperial Bureau of Entomology appeals strongly to workers in applied entomology all over the world. And the publications listed above must appeal to every one interested in agriculture.

Dr. W. R. Thompson, a Canadian by birth and for many years working as one of the foremost experts of the U. S. Bureau of Entomology, has for more than twenty years been studying various aspects of natural control, perhaps especially that part of this control brought about by the insect enemies of injurious insects. This long study by a man who is as sound a thinker as he is as an observer, and who in addition was the first of the entomologists to apply mathematics to the solution or explanation of such problems, renders his writings most important and provocative of lucid thought. When Dr. Thompson left the service of the United States government and became the superintendent of the Farnham House Laboratory it was a sad day for us; but we were readily consoled by the thought that all this work is for the ultimate good of all peoples and that the British Empire, including as it does possessions in practically every faunal zone of the globe, affords him a broader field for study and for the exploitation of his sound ideas.

The Farnham House Laboratory was not founded until 1927, and it exists for the furtherance of the control of the pests of agriculture and forestry by what is termed the biological method. The present publication is perhaps principally a report on the organization and program of the work of the laboratory, but it contains a most important general account of the problems that arise in natural control work and of the theoretical considerations that indicate lines of necessary research. No one could have done this better and more authoritatively than Dr. Thompson, and the paper under consideration will long be studied by those who wish to engage in such work in the most intelligent way.

The whole general problem is discussed in a most competent way, but students will probably welcome especially the section entitled "The Principles and Organization of Work on Biological Control," since it not only points out many vitally important things but gives consistently the reasons. No one without Dr. Thompson's long experience, beginning about 1910 in the gipsy moth parasite laboratory, could have done this so competently. Of especial interest is the long and somewhat philosophical treatment headed "The Results of Experiments." The author repeats some of his more or less theoretical arguments previously published, but restrains his mathematical tendencies to a single formula, much to the advantage of his non-mathematical readers.

The work already under way at the laboratory is discussed in some detail, and it is a delightful surprise to learn of its great scope. Not only are well-advanced investigations on the parasites of more than 21 insect pests of prime importance under way, but the control of noxious weeds, a subject of vital importance in New Zealand and Australia, has been assigned to the laboratory. A long list of projects submitted by dominions and colonies is given, and a partial but sufficiently full bibliography follows.

The Farnham House Laboratory is probably as well situated as it could be in England. It is well equipped and well staffed, and under its present most able director we may look for important results. The eight plates are for the most part photographic representations of the laboratory, its apparatus and methods.

There have been several dramatic and apparently completely successful experiments in the transfer from one country to another of parasitic or predatory insects. The introduction of the Australian *Novius cardinalis* into California in the 1880's heads the list. On the basis of that classic experiment has been founded most of the later work which now has become world wide. No introduction into continental regions has quite equaled it in its finality, although the introduction of *Prospaltella berlesei* from the United States into Italy to destroy the mulberry scale seems to approach it, and the carriage of *Aphelinus mali* from the United States to France, New Zealand, Australia and a number of other countries to kill the woolly apple aphis has been a repeated success.

Moreover, many other experiments of this sort have been moderately successful.

But, as has often been pointed out by writers, such introductions into islands of a simple native fauna and flora have a far better chance of success, as has been shown strikingly in the work that has been going on for nearly forty years in Hawaii. In fact it is fair to say that the important sugar industry of those islands almost owes its existence to-day to the work of this character done by Perkins, Muir and their colleagues and successors.

And now another dramatic achievement of this insular character has been brought about, and the story is told in all necessary scientific detail in the second of the publications listed above.

Copra is, next to sugar, the most important industry in Fiji, and since 1877 the foliage of the cocoa palms has been eaten by the larva of a zygaenid moth (*Levuana iridescens*) in increasing amounts until by 1924 the industry was threatened with absolute ruin. The green palms all over the island had become a dingy gray. Attempts to retard the increase and spread of the insect had utterly failed. In 1924 at the Wembly exposition in London, Sir J. M. Hedstrom, of Fiji, consulted with the home authorities and on the advice of Dr. (now Sir) G. A. K. Marshall it was decided to undertake a competent, and if necessary, long-time entomological investigation. Mr. Tothill, who had had much experience in biological control investigations in Canada and the United States, was appointed director of the campaign with Messrs. Taylor and Paine as assistants. The campaign was financed by a tax of two shillings and sixpence per ton of copra and an equal contribution from the general revenues, making an annual budget of £5,000.

It soon developed that a curious situation existed. The insect could be found only in Fiji, and yet no native parasite existed there. Explorations by H. A. Simmonds (then acting entomologist) in 1923, including the New Hebrides, Bismarcks, Solomon Islands, Lord Howe Island, Norfolk Island and North West New Guinea, did not result in the finding of the pest or of any allied species. It was therefore necessary to look elsewhere and to find if possible closely allied insects that were parasitized. Therefore Mr. A. M. Lea, government entomologist of South Australia, was sent to Malay and Java and eventually discovered and imported several parasites from Java of the allied genus Artona.

To cut a long story short, one of these parasites sent in from the Federated Malay States by Mr. B. A. R. Gater was a tachinid fly described by Aldrich as *Ptychomyia remota,* and this fly has proved to be the salvation of the islands. Although apparently normally a parasite of *Artona catoxantha,* it readily attacked the Levuana caterpillars and at the present time controls the pest perfectly.

The volume published by the Imperial Bureau of Entomology for the government of Fiji is wonderfully well done. In the introduction the authorship of the respective parts is carefully explained, and in the body of the book there is given in detail the history of the plague, an account of the recent campaign and a full account of the Levuana moth from the systematic, morphologic and biologic points of view and a very full account of the parasites and of the zygaenid moths most closely related to *Levuana iridescens.* The plates are beautifully done, a number of them being in colors.

The great value of the tachinid flies has always been recognized by the agricultural entomologists, but this is the first time in the history of parasite introduction that one of them has accomplished such a dramatic result. We are indeed fortunate that the whole story has been published and with such detail as to its scientific aspects.

L. O. Howard

U. S. Bureau of Entomology

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A VARIABLE RESISTANCE PNEUMOGRAPH AND AN ELECTROMAGNETIC TAMBOUR

In making kymograph or photographic records of such variables as muscle movements the use of air pressure systems, *i.e.,* pneumographs and tambours, involves several difficulties. Air leakage possibilities are always present, and, what is sometimes even more productive of error, the pneumatic system requires the making of records in close proximity to the variable being recorded. The constant attention which must be paid to such apparatus has made it appear that electrical equipment might be utilized to the exclusion of air systems.

The device described is basic for a large number of specific pieces of apparatus which may be constructed by the individual experimenter.

Fig. 1 shows the light, soft iron lever carrying a mirror or marking directly on the kymograph drum. The excursions of the lever may be delimited by a variable resistance (R). The primary control of the

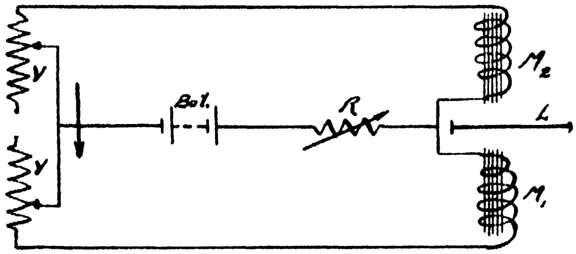

FIG. 1. V., V., balanced, variable resistances; Bat., battery; R., limiting, control resistance; M_1., M_2., electromagnets; L., soft iron lever.

lever, however, is a function of the balanced variable resistances in the outer electromagnet circuit. When used, for example, in making thoracic breathing records, the variable resistances are secured on a light frame and activated by a simple cog device, the resistance in this case being varied by a wire passing over the pulley-mounts of a modification of Hall's spirograph belt, and by an opposition spring. If in the diagram the arrow indicates the direction of the movement of the resistance contacts away from the indicated balanced or zero position upon inspiration, the electromagnet (M_1) will be energized, attracting the lever and resulting in a downward record on the kymograph. With expiration the resistance of the circuit will be changed, and the lever arm will pass through the base line (zero) position and upward under the influence of (M_2). The resistance of the equal variable resistances, the resistance of the delimiting control (R), the size of the electromagnets and the voltage applied to the circuit will depend on the specific uses of the equipment and the distance at which it is desired to operate the electromagnetic tambour.

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BRAZILIN STAIN ON SMEAR PREPARATIONS OF OENOTHERA POLLEN MOTHER CELLS

FOR the study of chromosomes in Oenothera pollen mother cells it has been the experience of many that the aceto-carmine method of smear preparations does not yield satisfactory results. Recently, however, Belling in his paper[1] and lately in his book[2] has recommended the use of a rather uncommon stain, brazilin, in connection with smear preparations for the study of chromosomes in pollen mother cells. The writer, after having tried and abandoned the aceto-carmine method, resorted to this recent method of Belling. This was used on the pollen mother cells of different species and mutants of Oenothera, and the results thus obtained in picturing chromomeres, chromosome rings and other configurations were of such an order of excellence that the description of the technique becomes advisable. The following procedure, based mostly on Belling's original method, was found most useful with Oenothera pollen mother cells.

The Oenothera buds are collected in the field and may be put in a vial containing water to keep them fresh. In the laboratory the segments of anthers are clipped off and arranged side by side on a microscope slide. To assure getting mitotic figures it is advisable to place on the slide anthers from buds of different sizes. A second slide held crosswise is then squeezed circularly with force enough to firmly extrude the pollen mother cells. The placing of anther segments on the slide and the squeezing should last not more than one minute. The two slides are then immediately inverted over parallel supports placed in a dish containing the fixing fluid. This fluid is a mixture of equal parts of two solutions which Belling designated as Solution A (chromic acid crystals 5 g, glacial acetic acid 50 cc, distilled water 320 cc) and Solution B (formalin 200 cc, distilled water 175 cc, or especially for metaphase preparations formalin 100 cc, distilled water 275 cc). The two solutions are mixed only when ready for use. Oenothera anthers seem to be sufficiently fixed in from 2 to 6 hours, but 3 to 4 hours' fixation has been found to give excellent preparations. The slides are then transferred to a dish containing 4 parts of water and one part of solution A. Here they are placed right side up and the thick fragments and anther walls may be removed. They are left in this dish from 10 to 15 minutes in order to remove the formalin of the fixative. The slides are then run through 15 per cent., 30 per cent. and 50 per cent. alcohols (3 to 5 minutes each) up to 70 per cent. where they are left overnight. From 70 per cent. alcohol they are put in a mordant solution (1 per cent. solution of ferric ammonia alum in 70 per cent. alcohol). The mordant solution is always prepared fresh. They remain in the mordant at least overnight. From the mordant, the slides are washed from 30 minutes to one hour in 70 per cent. alcohol. After being washed, they are then put in one half per cent. of brazilin stain in 70 per cent. alcohol. (Brazilin stain solution was found ripe a week after it had been prepared.) The ripe brazilin solution sufficiently stained the slides within 2 to 6 hours. They are then washed briefly in 70 per cent. alcohol and differentiated in 1 per cent. iron alum ammonia in

[1] J. Belling, "A Method for the Study of Chromosomes in Pollen Mother Cells," *University of California Publications in Botany*, 14 (No. 9): 293–299, 1928.

[2] J. Belling, "The Use of the Microscope," 315 pp., McGraw-Hill Book Company, 1930.

70 per cent. alcohol. When examined under the microscope, smears rightly stained with brazilin show the chromosomes brownish-black or black, the cytoplasm pink or straw colored and the cell wall colorless. The small chromosomes of Oenothera at the prophase, in rings or chains, are distinctly clear. Threads in synizesis stages can be easily observed. After correct differentiation which may last from 5 to 10 minutes, the slides are washed in 70 per cent. alcohol and 95 per cent. alcohol (5 to 10 minutes each). They are then passed (2 to 5 minutes each) through (*a*) absolute alcohol, (*b*) mixture of equal volumes of absolute alcohol and cedar oil, (*c*) mixture of equal volumes of xylol and thin cedar oil, (*d*) mixture of 9 parts xylol and one part cedar oil and finally (*e*) absolute xylol. The preparations are mounted in Canada balsam. Critically sharp and clear figures are shown by the preparations when viewed in the microscope with oil immersion objective, and the use of Wratten filters may even be dispensed with.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

JOINT MEETING OF THE EXECUTIVE COMMITTEE OF THE AMERICAN ASSOCIATION AND THE EXECUTIVE COMMITTEE OF THE PACIFIC DIVISION

THE executive committee of the American Association met in joint session with the executive committee of the Pacific Division at the Faculty Club of the University of California, Berkeley, on Wednesday, September 17. The following members were present: Cattell, Curtiss, Millikan and Morgan, of the national executive committee, and Barnett, Benfield, Clausen, Loeb, Martin, Moore, Smith, Vaughan and Luck, of the Pacific Division. Morning and afternoon sessions were held. The following items of business were transacted:

1. The minutes of the meeting of April 27 were ordered approved as circulated.

2. A report of the permanent secretary under date of September 1, 1930, was presented. The financial condition of the association was shown to be satisfactory, although the need of caution in embarking upon new expenditures of any considerable magnitude was indicated. Receipts have increased with growth in membership, but expenditures have grown steadily as the activities of the association have expanded. It is becoming increasingly desirable that local guarantees for the support of the meetings be large enough to cover the costs without drawing upon the current funds of the association. Plans have not been formulated for financing the newly inaugurated summer meetings. About $2,500 of the current funds for 1929–30 will be carried over into the new fiscal year. In addition, there are reserves of approximately $7,200 in the publication, meeting and emergency funds. The membership of the association now exceeds 19,000, an increase of 600 in the past year, and of 7,500 during the decade, 1920–1930. About 50,000 letters will be sent out in October to members of associated organizations inviting the recipients to membership in the American Association. Fifteen thousand others will be circularized before the Cleveland meeting. The new fellowship nomination plan has resulted in the nomination of several hundred candidates by the respective section committees. The total number of fellows now approximates 6,000.

3. The resignation of Dr. S. F. Trelease from the secretaryship of the council was announced. Dr. Trelease is also withdrawing as program editor, a position which he has ably filled for a number of years. A committee was appointed consisting of J. McK. Cattell, D. R. Curtiss and B. E. Livingston to nominate, for consideration by the council, successors to Dr. Trelease.

4. The chairman summarized an extensive report from Dr. Rodney True, secretary of the committee of one hundred on scientific research. The work of the committee in encouraging and promoting the adoption of adequate salary scales by universities has received commendation. The committee seeks authority to solicit from some suitable foundation an appropriation of $20,000 to further this phase of the work. It proposes that a representative be engaged to study the policies on salary, research, retirement provisions and teaching load, as practiced within a large number of American colleges and universities. The secretary of the committee of one hundred on scientific research was instructed to call a meeting of the committee at Cleveland to consider the work and organization of the special committees.

5. The relations between the social and natural sciences in the Pacific Coast region were considered. The special committee, appointed to inquire into these relationships, reported that steps should be taken in the organization of the Pasadena meeting to develop a special program for the social sciences. Specific

recommendations with this end in view were made. The committee is in agreement that the time is ripe for the promotion of close relationships between these two fields of knowledge. The committee was authorized to coopt three members in the social and economic sciences within the Pacific region.

6. The Xi Sigma Pi Forestry Fraternity was received into membership as an associated society.

7. The Academy of Science of St. Louis was elected an affiliated academy.

8. Resolutions adopted by the Southwestern Division of the American Association at its eleventh annual meeting were received.

9. T. H. Morgan, president of the American Association, was appointed by the chairman to be the representative of the American Association for the Advancement of Science at the inauguration of Robert Gordon Sproul as president of the University of California.

10. The appointment of a representative to the advisory board and council of the Association of International Patentees was deferred pending the receipt of further information.

11. J. C. Merriam was appointed to represent the American Association for the Advancement of Science on the council of the National Parks Association.

12. The election of a permanent secretary to succeed Dr. B. E. Livingston was considered at length. The chairman reported that 144 nominations had been received. Although a preliminary selection of candidates was made, it was agreed that final action must await the settlement of several questions pertinent to the organization and work of the association. There is the possibility of reorganization along regional lines, in the event of which several part-time secretaries would be required. The nature of the responsibilities and duties of the permanent secretary, the desirability of part-time or full-time service, the location of the association headquarters and other related matters require decision before an election is made.

13. The third week of June, 1931, was approved as the time of holding the Pasadena meeting, unless the local committee should regard the fourth week as preferable. The duration of the meeting was left to the decision of the executive committee of the Pacific Division, which, with the local committee, was entrusted with the arrangements and organization of the meeting.

14. On nomination by Walter S. Adams and R. A. Millikan, the executive committee of the Pacific Division elected the following as members of the local committee for the Pasadena meeting:

Paul Merrill, *chairman*, Mount Wilson Observatory.
H. D. Babcock, Mount Wilson Observatory.
John P. Buwalda, California Institute of Technology.
E. C. Watson, California Institute of Technology.
Linus Pauling, California Institute of Technology.
R. O. Schad, Huntington Library and Art Gallery.

15. The committee adjourned to reassemble in October or November at the call of the chairman.

J. MURRAY LUCK, *Secretary,*
Pacific Division

THE NATIONAL ACADEMY OF SCIENCES

AT the autumn meeting of the National Academy of Sciences, held in California from September 18 to 23, the following papers were presented at the meetings held at the University of California and the California Institute of Technology:

Design problems of the Golden Gate bridge: CHARLES DERLETH, JR. (introduced by A. O. Leuschner). A century ago suspension bridges were built with iron chains. Vertical suspenders supported the floor and live load. In 1816 Telford built the Menai Bridge with a 580-ft. span. The bridge over the Danube at Budapest had a 666-ft. span; the Clifton Bridge near Bristol, England, a 702-ft. All had iron chains. The first iron drawn wire cable was introduced in 1816 by White and Hazzard for a foot bridge across the Schuylkill at Philadelphia, span 408 ft. Since then there has been gradual development using straight wire cables. Long spans soon were built in America at New York, Niagara Falls and across the Ohio. Until recently the maximum spans did not exceed 1,600 ft. Modern erection methods, the introduction of the deflection theory, improved devices for cable spinning, etc., have made possible great openings. To-day a 3,500-ft. span is building across the Hudson River and one of 4,200 ft. has been designed for the Golden Gate at San Francisco. Rankine in England and Ritter in Switzerland developed the rigid stiffening truss assuming that the suspended truss remains absolutely rigid under live load, the original cable curve being undisturbed. The assumption involved the elimination of dead load stresses in the stiffening truss. As spans increase, the error of this assumption is serious and uneconomic. For long spans a stiffening truss of reasonable proportions becomes increasingly flexible, changing the shape and deflection not only of the stiffening truss but also of the cable. These distortions can not be neglected. The cable, suspenders and stiffening truss constitute one composite elastic structure. Distortions of one part affect the stresses in all the others. The cable is the most rigid member. The stiffening trusses relatively are slender. Therefore any change in shape of the cable curve causes the total cable tension to affect the stiffening truss. Thus the dead loads in the cable tension introduce stresses due to dead load in the stiffening trusses. In

the design of long-span bridges in recent decades, the deflection theory has shown that by its application marked economies can be introduced. The elastic theory of Mueller-Breslau and Melan no longer is applicable. When applied, the elastic theory gives stresses which are incorrect and much greater than they should be.

The earthquakes of November 28, 1929, and the surface layers of the earth in California: Perry Byerly (introduced by A. C. Lawson). On November 28, 1929, at about 11h. 49m. A.M., P.S.T., the west central section of California and the neighboring portion of Nevada was shaken by an earthquake which reached an intensity of VII on the Rossi-Forel scale near Aberdeen, California. A study of the records of this earthquake from eleven stations in California and Nevada has been made. The epicenter was placed at 37° 31′ North Latitude, 119° 02′ West Longitude. The time of occurrence was 11h. 48m. 52s. This epicenter is consistent with the area in which the earthquake was felt since it is near the center of that area although it is not at the point where the greatest intensity was reported. It is consistent with the directions from the three of the nearer stations as given from the first arriving longitudinal wave. However, the direction method in this case is open to some error. This epicenter allows a reasonable explanation of the travel time curves and was adopted after many trials. The arrival times of the various waves at each station were plotted against the epicentral distance of the station. It was found that straight lines could be drawn through the points and the waves explained as has been done in Europe. More than one set of longitudinal waves were observed as well as more than one set of transverse waves. In this interpretation there are recognized (1) the direct longitudinal wave in the upper or granitic layer ($v = 5.8$ km/sec), (2) the longitudinal wave along the surface, set up by the incidence on the surface of the transverse wave from the focus ($v = 5.5$ km/sec), (3) the longitudinal wave which has penetrated the intermediate layer ($v = 7.4$ km/sec), (4) the longitudinal wave which has penetrated to the underlying medium ($v = 8.6$ km/sec), (5) the direct transverse wave ($v = 3.3$ km/sec), (6) a later wave probably of surface type ($v = 3.2$ km/sec), (7) the transverse wave which has penetrated to the underlying medium ($v = 4.6$ km/sec), (8) a wave arriving between the two general groups of primary and secondary types; the position of its travel time curve suggests that this wave may have its genesis in the incidence on the surface of the longitudinal wave which has penetrated the intermediate layer ($v = 3.4$ km/sec). A second earthquake, apparently from the same focus, occurred some three minutes later. Although its beginnings are somewhat obscured by the first earthquake its travel time curves as observed are consistent with those of the first shock. The difference in the time intercepts of the waves of types (1) and (2) above gives a depth of focus for this earthquake of about 4 kilometers. The positions of the curves of waves (1), (3) and (4) lead to values of the thicknesses of the layers. It is concluded that the thickness of the granitic layer under this Sierran region is about 30 kilometers. The thickness of the intermediate layer is about 35 kilometers. The writer has recently obtained values for the surface layers under the Pacific. These would indicate that the Pacific region is not in isostatic balance with the Sierra region. It is possible that the region has not yet had time to attain this balance.

The dynamic effects of earthquakes on engineering structures: Lydik Jacobsen (introduced by W. F. Durand). Since 1927, a special type of vibration research has been carried out by the School of Engineering at Stanford University. The object of the investigations is to study the dynamic behavior of structures subjected to definite types of ground vibrations, especially those resembling an idealized horizontal component of the earth motion occurring during an earthquake. For economic reasons it is not feasible to make full scale structures and to provide for their adequate testing apparatus. A program involving experiments on models of common types of building construction is therefore being undertaken by means of a nine by twelve feet structural steel platform mounted on street car wheels. The platform or table is capable of executing, simultaneously or independently, two types of motion in one direction, namely, a steady, forced, harmonic vibration, and a transitory, free, harmonic vibration. The paper contains a short description of the vibrating table and a summary of the problems that are being investigated by the mechanical equipment. The question of dynamic similitude has been given attention from the experimental side; thus, models of two simple structures have been built to five different scales of the linear dimensions, ranging from full scale to one quarter scale.

The pressure of the wind on large chimneys: Hugh L. Dryden and George C. Hill (introduced by George K. Burgess). The practical problem of determining the wind pressure to be used in the design of a large chimney requires for its solution the determination of the variation of the wind pressure on a cylinder with the size of the cylinder and the speed of the wind. This task is a very interesting scientific problem, since experiments on the largest cylinders (8 to 12 inches in diameter) which can be used in wind tunnels show that the wind pressure on a large cylinder is very much less than that which would be obtained by increasing the pressure on a small cylinder in the ratio of the exposed areas. It is found necessary to supplement experiments in wind tunnels by experiments on large cylinders in natural winds. Measurements in natural winds have been made on an experimental stack ten feet in diameter and thirty feet high erected on the roof of the West Building of the Bureau of Standards. Pressures were measured at twenty-four stations around the circumference at a single elevation, about two thirds of the height from the base of the stack. The wind speed was determined by means of a pitot-static tube mounted on a weathervane about ten feet higher than the top of the stack. A method for determining the wind speed from the distribution of the pressure has been developed and the results have been compared with the direct mea-

surements. The method assumes that the static pressure is equal to the observed pressure on the cylinder at a certain zonal angle determined by extrapolation of data obtained in wind tunnel tests. Direct measurements of the overturning moment were obtained by mounting the stack on pressure capsules. The value of the average wind pressure determined from the overturning moment is somewhat higher than the value determined from the pressures at a single elevation. The pressure distribution at a single elevation was also measured on the power plant stack of the Bureau of Standards. The general conclusions drawn from the tests are as follows: (1) The wind pressure on a chimney at a given wind speed is a function of the ratio of the height of the chimney to its diameter and possibly also of the roughness of its surface. (2) Experiments on small cylinders can not be directly used to predict the wind pressure on a full scale chimney because of the large scale effect. (3) A wind pressure corresponding to 20 lbs. per square foot of projected area at a wind speed of 100 miles per hour is a safe value to use in designing chimneys of which the exposed height does not exceed 10 times the diameter. (4) The pressure may reach large values locally and this may need consideration in the design of thin-walled stacks of large diameter. (5) Further experiments are necessary to obtain satisfactory information as to the variation of wind pressure with the ratio of height to diameter. A full account of the work is given in Research Paper 221 ("Wind Pressure on Circular Cylinders and Chimneys," by Hugh L. Dryden and George C. Hill) appearing in the September, 1930, issue of the Bureau of Standards *Journal of Research.*

Circulation of the waters of the Pacific Ocean as indicated by their physical and chemical properties: E. G. MOBERG (introduced by T. Wayland Vaughan). The circulation of the water in the open ocean, especially below the surface, can not be measured by direct methods but is deduced from the variations in the physical and chemical properties of the water. By such means it has been found that most of the deep water in the Atlantic is derived from the surface, the sinking of the water taking place in the north central part of this ocean. A considerable amount of water enters the Atlantic from the Antarctic and moves in two layers, one immediately over the bottom and the other at a depth of about 1,000 meters. A current system similar to that in the Atlantic has been found to exist in the Indian Ocean, and prior to the last cruise of the *Carnegie* it was thought that the circulation in the Pacific resembled that of the other two oceans. The temperature and salinity data obtained by the *Carnegie* indicate no important amount of sinking of surface water in any part of the Pacific and the relatively high temperatures at great depths show that no appreciable quantities of water enter the Pacific directly from the Antarctic. Furthermore, it was found that the deep water in both the North and the South Pacific has a remarkably low oxygen content which is incompatible with the theory that this water is derived either from the surface or by a direct route from the Antarctic. It is probable that most of the water of the Pacific enters south of Australia from the Indian Ocean where is it formed by the mixing of water returning from the northern part of this ocean with water from the Antarctic.

On the favorable action of certain fats and of the glycerides of certain single fatty acids on animals deprived of vitamin B: HERBERT M. EVANS and SAMUEL LEPKOVSKY. The addition of fats to a sugar-casein diet, as we have already shown, acts to spare body requirements for the antineuritic vitamin B. The attention of nutrition students can not fail to be attracted by the fact that in spite of the complete withdrawal of B, the inclusion of 50 per cent. fat in such diets enables animals to achieve considerable growth and to survive for many months. Controls die within a month. Though the ultimate growth and survival periods are both lessened, 25 per cent. fat also bestows favorable effects on animals deprived of B. The effect is slight with cottonseed oil (Wesson oil) and only slightly better with lard, but is marked with cocoanut oil, whether natural or synthetic. (Synthetic cocoanut oil was prepared by saponifying cocoanut oil, collecting the fatty acids, washing, distilling and finally esterifying them with freshly distilled glycerol.) The favorable effects of cocoanut oil are not due to more complete utilization of this fat, for stool analyses showed equally good utilization of the lard and cottonseed oil. Single fatty acids were prepared from cocoanut oil. Commercial stearic and oleic acids were purified by distillation. Synthetic homogeneous "fats" were made as mixtures of di- and tri-glycerides in each case of a single fatty acid. Animals deprived of vitamin B were not appreciably helped by the inclusion of 25 per cent. of the glycerides of stearic, of palmitic or of oleic acid, but considerably more by those of lauric or of capric acid. On the other hand the glycerides of myristic and capryllic acid were surprisingly efficacious. It is possible to look upon the favorable effect of cocoanut oil as due to its content in these two fatty acids. As was the case with natural fats so also with the glycerides of single fatty acids, it is impossible to ascribe the favorable effects of certain glycerides to their more complete utilization by the body; oleic, lauric and capric glycerides are far less efficacious, but are just as well utilized as are those of myristic and capryllic acids. We are not at present able to assign a particular physical or chemical characteristic of fats as the cause of this obscure new physiologic rôle in connection with water-soluble antineuritic B. It is further striking that while the separate glycerides of both stearic and of oleic acid have little efficacy, a mixture of these glycerides (four parts stearic with six parts oleic) is markedly beneficial to animals deprived of B. The facts presented would appear to force us to recognize new nutritive peculiarities in fats, quite apart from their caloric values or their content in the fat soluble vitamins at present known to science.

The importance of circulatory balance in the survival of replanted limbs: FREDERICK LEET REICHERT (introduced by Herbert M. Evans). Experience with wounds in the World War has definitely indicated that in arterial ligation the incidence of gangrene may be di-

minished by the simultaneous occlusion of the accompanying vein. By means of the experimental replantation of limbs the effect of simultaneous ligation of the main artery and vein to an extremity as compared with the effect of ligation of the artery or vein alone has been established chronologically. Gangrene does not develop if the main vein is ligated five or more days after replantation whereas the artery alone can not be safely occluded until the fourteenth day. The time interval essential to a safe arterial ligation can be diminished to seven days when a simultaneous ligation of artery and vein is performed. It is significant that the survival of the extremity after arterial ligation depends on the lapse of only a few hours before occlusion of the accompanying vein.

Bound water and free water in cells: L. B. Becking (introduced by H. M. Evans). The experiments of de Vries which substantiated Van 't Hoff's analogue on gas theory were performed with cells in which the swelling capacity of the protoplasm was insignificant. Osmotic laws fail to apply when the amount of hydrophilic colloid in cells is large. In the case of organisms living in concentrated salt solutions the amount of "bound" water is so great that osmotic laws no longer apply. Living cells, in general, display both osmotic and swelling activity. An interpretation of the processes of water absorption in terms of vapor pressure has been attempted on the basis of Katz's and Polanyi's deductions on swelling pressure and vapor tension of hydrophilic colloids.

The relation of bile to the intestinal absorption of vitamin A in the rat: Carl L. A. Schmidt and Werner Schmidt (introduced by T. Wayland Vaughan). Experiments were carried out on rats which had been maintained on a low level of vitamin A to determine whether this vitamin is absorbed from the gastro-intestinal tract when bile is excluded by ligating and sectioning the common bile duct. The vaginal smear picture was used as a criterion to determine the absorption of the vitamin. It was found that icterus does not lead to the continuous appearance of cornified cells in the vaginal smears of animals which had been maintained on a diet adequate in vitamin A. When the abdomens of animals which had been maintained on a diet low in vitamin A were opened and closed surgically without, however, inducing icterus, subsequent administration of cod-liver oil restored the vaginal smear picture to normal. When icterus was induced in animals which had been maintained on a diet low in vitamin A by ligating and sectioning the common bile duct, the subsequent administration of cod-liver oil *per os* led to the reappearance of the normal vaginal smear picture in a certain percentage of the animals. This is interpreted as indicating absorption of vitamin A from the gastro-intestinal tract in the absence of bile. Both the mortality and the percentage of icteric rats which failed to respond to cod-liver oil when administered subcutaneously or *per os* are high. In several experimental icteric rats it was possible to restore the normal vaginal smear pictures by administration of cod-liver oil *per os*, then again to deplete the storage of vitamin A to such a level that only cornified cells were formed in the vaginal smears and a second time to restore the normal vaginal smear pictures by giving cod-liver oil *per os*.

The origin of limestone caverns: W. M. Davis. It is proposed, by extending the theory advocated by the German geographer, Grund, to explain the excavation of limestone caverns and the prevalent network pattern of their passages by the solvent action of ground water below the water table; and then to account for their more or less complete replenishment with dripstones by evaporation of percolating vadose water after regional elevation or other adequate cause has compelled the withdrawal of the ground water and its replacement by ground air.

Biotic cementation in coral reefs: William Albert Setchell. Charles Darwin formulated a hypothesis to account for the origin and development of coral reefs. His fundamental arguments relied upon three sets of subsidiary hypotheses, *viz.:* I. Depth limitation of reef-forming corals; II. interconvertibility, *i.e.*, fringing into barrier, and barrier into atoll forms; with the resultant hypothesis, III, subsidence of the supporting platforms. Hypothesis I, founded on observation, is incomplete, since it overlooks the important rôle of cementing organisms, particularly that of the nullipores. Darwin and most later observers have assumed, but largely without supporting data, cementation, but largely inorganic in nature. At present the tendency is to include under coral reefs any calcareous reef structures whose components are largely corals, and to such an extreme has this view been carried that non-cemented structures have been included; *e.g.*, reefs, or more properly perhaps reef-like structures of coral rubble have been described in all seriousness as coral reefs, supposedly in the sense of Darwin, Dana, Agassiz, etc., in which reef growth has nothing of symbiotic cooperation to bring about the zonation so fundamental in the discussion of Darwin's hypothesis. Such extension of the term, without proper limitation, confuses the issue beyond measure and associates those marvelous structures where the cementation is biotic and whose controlling forces are living organisms with inchoate masses thrown into certain form and held to that form by nonliving, purely physical forces. Such calcareous reefs can not have growth in any biological sense, nor can they throw light on the origin and development of reefs in the Darwin-Dana sense.

The fossil flora of Goshen, Oregon, and its bearing on the problems of climatic change: Ralph W. Chaney (introduced by David White). The Goshen flora of west central Oregon is made up of species many of which have generic equivalents in the subtropical forests of Central America; to a lesser extent the modern forests of central and southern China and of the Philippines contain elements corresponding to those of the fossil flora. It may be concluded that the physical conditions in western Oregon during the Eocene approached those on the Pacific slope of Central America to-day, with a rainfall of about 70 inches and a relatively high temperature. The Goshen flora represents the first unified fossil assemblage of a

subtropical type which has been studied on the Pacific Coast, where all the later Tertiary floras are typically temperate. It has much in common with the Eocene floras described from the Gulf states, but differs from them in much the same way that the modern forests of the Pacific slope differ from those of the Atlantic slope in Panama. Containing several genera to-day common to the neo-tropical and paleo-tropical forests, the Goshen flora may represent a record of the northward extension of a forest which had its origin in high latitudes at a time when there was a greater degree of climatic uniformity than now obtains, and whose survivors are found to-day only in the lower latitudes of both hemispheres.

Living micro-organisms in ancient rocks: C. B. LIPMAN (introduced by A. C. Lawson). Starting three years ago in a search for living micro-organisms in pre-Cambrian rocks I have continued the work and, on account of the sparseness of the flora in the pre-Cambrian rocks, decided to study anthracite coal inasmuch as it promised a richer flora. Many experiments have been carried out which leave no room for doubt of the existence of a bacterial population probably in some spore or resting stage inside of anthracite coal deriving both from Pennsylvania and from Wales. The final question as to whether these micro-organisms have found entrance into the inside of the anthracite coal measures in recent time or have been locked up in the coal measures from the time of their formation is under investigation.

The spherant, an instrument for observing hour angle or latitude directly: HOWARD B. KASTER. The instrument described in this paper and exhibited at the meeting has been under development at the University of California for several years. It breaks the old tradition that a navigator, in order to find his position, must measure an altitude and then solve a spherical triangle. The instrument gives directly either hour angle or latitude. The observed hour angle, combined with the proper Greenwich hour angle from a watch or chronometer, yields the longitude. Usually such latitudes and longitudes are not independent but lie along a Sumner line, as in the case of reduced sextant observations. The advantage lies in the elimination of practically all computation or use of tables. The instrument has the same weight as the average sextant, and *with the same amount of practice* is as easily handled. It is called a spherant.

A radio system for blind landing of aircraft in fog: H. DIAMOND and F. W. DUNMORE (introduced by George K. Burgess). This system includes three elements in order to indicate the position of the aircraft in three dimensions as it approaches and reaches the point of landing. (1) *Lateral position*—Such position given for the purpose of keeping the airplane directed to and over the runway is indicated by two vibrating reeds on the pilot's instrument board, the driving electromagnets of which are connected to the output of the airplane's radio receiver. These reeds, one of which is mechanically tuned to 65 cycles and the other to 86.7 cycles, are actuated by a radio signal sent from two coil antennas crossed at 90°, the signal from one coil antenna being modulated at 65 cycles and that from the other at 86.7 cycles. On the course (*i.e.*, along the line bisecting the angle between the two antennas) the reed vibration amplitudes are equal. Off the course they are unequal, the reed vibrating with the greater amplitude being on the side to which the airplane has deviated. An automatic volume control feature is used to keep the reed amplitudes within bounds as the field is approached. (2) *Vertical guidance*—A high frequency (100 megacycles, 3 meters) beam directed over the runway at an angle of 8° above the horizontal and located at the further end of the landing field is used for such guidance. On the airplane, the signal current in the output circuit of the special high-frequency receiving set employed is rectified and passed through a d.c. microammeter mounted on the instrument board. The airplane does not fly on the axis of the beam, but on a curved path under the beam whose curvature diminishes as the ground is approached. The path is the line of equal intensity of received signal below the axis of the beam. The diminution of intensity as the airplane drops below the beam axis is compensated by the increase of intensity due to approaching the beam transmitter. Thus, by flying the airplane along such a path as to keep the deflection of the microammeter on the instrument board constant, the pilot comes down to ground on a curved line suitable for landing. No manipulations on the part of the pilot are required. The tuning is fixed. Since a line of constant field intensity is followed no control of volume is necessary. (3) *Longitudinal guidance*—A field boundary marker beacon is used for this purpose. It operates on the same carrier frequency as the runway localizing beacon and both beacons are received simultaneously on the medium-frequency receiving set. A modulation frequency of 1,000 cycles is used. A coil antenna oriented to give a minimum signal zone along the border of the field is used, the minimum signal indicating to the pilot that he is over the edge of the field.

Some aspects of Martian meteorology suggested by the behavior of Martian mists and clouds: W. H. WRIGHT.

The principle of identity: G. N. LEWIS.

On the production of high speed protons: ERNEST O. LAWRENCE and N. E. EDLEFSEN (introduced by G. N. Lewis). Very little is known about nuclear properties of atoms because of the difficulties inherent in excitation of nuclear transitions in the laboratory. The study of the nucleus would be greatly facilitated by the development of a source of high speed protons having kinetic energies of about one million volt-electrons. The straightforward method of accelerating protons through the requisite difference of potential presents great difficulties associated with the high electric fields necessarily involved. Apart from obvious difficulties in obtaining such high potentials with proper insulation, there is the problem of development of a vacuum tube suitable for such voltages. A method for the acceleration of protons to high speeds which does not involve these difficulties is as follows. Semicircular hollow plates in a vacuum not unlike duants of an electrometer are placed in a

uniform magnetic field which is normal to the plane of the plates. The diametral edges of the plates are crossed by a grid of wires so that inside each pair of plates there is an electric field free region. The two pairs of plates are joined to an inductance thereby serving as the condenser of a high frequency oscillatory circuit. Impressed oscillations then produce an alternating electric field in the space between the grids of the two pairs of plates which is perpendicular to the magnetic field. Thus during one half cycle the electric field accelerates protons into the region between one of the pairs of plates where they are bent around on a circular path by the magnetic field and eventually emerge again into the region between the grids. If now the time required for the passage along the semi-circular path inside the plates equals the half period of the oscillations, the protons will enter the region between the grids when the field has reversed direction and thereby will receive an additional acceleration. Passing into the interior of the other pair of plates the protons continue on a circular path of larger radius coming out between the grids where again the field has reversed and the protons are accelerated into the region of the first pair of plates, etc. Because the radii of the circular paths are proportional to the velocities of the protons the time required for traversal of a semicircular path is independent of the radius of the circle. Therefore once the protons are in synchronism with the oscillating field they continue indefinitely to be accelerated on passing through the region between the grids, and spiraling around on ever-widening circles gain more and more kinetic energy from the oscillating field. For example, oscillations of 10,000 volts and 20 meters wave-length impressed on plates of 10 cm radius in a magnetic field of 15,000 Gauss will yield protons having about one million volt-electrons of kinetic energy. The method is being developed in this laboratory, and preliminary experiments indicate that there are probably no serious difficulties in the way of obtaining protons having high enough speeds to be useful for studies of atomic nuclei.

The effects of rediffusion of cathode rays upon X-ray structure: D. L. Webster, H. Clark and W. W. Hansen, Stanford University. An extremely thin target, for an X-ray tube for spectral line intensity measurements, may be made by depositing the metal to be investigated on a block of beryllium. The intensities of the lines must then be corrected by subtracting the intensities due to such cathode rays as are "rediffused" from the beryllium, thus penetrating the target a second time. This correction was tentatively estimated, in a preliminary report[1] on such measurements, for silver, as "a few per cent." But Wisshak,[2] in discussing his recent measurements of X-rays from thick targets, disagrees with our results by much greater percentages, and concludes that the difference must be attributed to rediffusion. This makes it desirable to calculate the effect of rediffusion more exactly. The question becomes especially important because of Bethe's[3] new theory of ionization by electron impact. If Wisshak's data and his corrections to them are accurate, Bethe's theory must be quite inapplicable to the inner electrons. On the other hand, its deviations from our data are only of the order of 10%. So if our data are accurate and our corrections are small, it is at least a reasonable approximation. To calculate these corrections, we need first the rediffusion constant for beryllium. From Schonland's[4] measurements on other metals, and Wentzel's[5] theory, we estimate this as 0.044. We assume the rediffusion velocity spectrum to be of a general type found by Wagner;[6] but to insure against the uncertainty in the translation of his photographic densities into numbers of electrons, calculations are made for a great variety of values of the mean energy of rediffusion. It is found that for all voltages up to 3 times the excitation voltage V_K, the results are but little affected by any reasonable changes in this quantity. Taking the intensity at 2 V_K as a standard by which to fix the arbitrary intensity unit, the correction at voltages up to 3 V_K never exceeds 3 or 4½ per cent.; furthermore, it is partially cancelled, by a correction for the lengthening of the paths within the silver by diffusion there. The comparison with Bethe's theory, made above, is therefore practically unaffected. For thick targets, rediffusion makes the intensity at any frequency increase less rapidly with voltage than it would without rediffusion; so the corrections are of opposite sign from those for thin targets. For silver, expressed as percentages of the intensity, they are about 2 to 4 times as great. On continuous spectra, these calculations practically verify Kramers' suggestion, that the non-linear term in the continuous intensity function is due to rediffusion; but there is a residue, probably due to the diffusion occurring before rediffusion. For when the cathode rays first lose their parallelism, they lose their ability to emit polarized X-rays. This initial diffusion therefore affects the intensities observed in any given direction, and it probably accounts, in part at least, for the dependence of the nonlinear intensity term on the direction.

Phase rule equilibria of horse serum globulin: Eloise Jameson and J. W. McBain (introduced by W. C. Bray). Although proteins are of great biological importance, still no consistent account of the equilibria into which they enter can be obtained from existing scientific literature. Taking advantage of the recent developments in the isolation of unaltered proteins as tested by the experiments of Svedberg with the ultra centrifuge, a specimen of horse serum globulin was prepared by his method. Observations were made of the various physical states it could assume and the conditions under which these forms and their solutions may exist. The composition as regards amounts of protein, water, salt and acid of the material in these states, as well as some other properties, have been determined. The study of the equilibria between the

[1] D. L. Webster, H. Clark, R. M. Yeatman and W. W. Hansen, *Proc.* Nat. Acad. Sci., *14*, 679, 1928.

[2] F. Wisshak, *Ann. der Phys.*, *5*, 507, 1930.

[3] H. Bethe, *ibid.*, *5*, 325, 1930.

[4] B. F. J. Schonland, *Proc.* Roy. Soc., A *108*, 187, 1925.

[5] G. Wentzel, *Ann. der Phys.*, *70*, 561, 1923.

[6] P. B. Wagner, *Phys. Rev.*, *35*, 98, 1930.

various forms of globulin and its solutions was carried out by analysis of the two phases appearing upon evaporation of a globulin solution, or upon addition of ammonium sulphate to the solution, or upon dialysis of the same. A remarkable similarity to soap was observed, both between the forms of globulin and soap separating and the shapes of the areas representing the solutions of the two substances. After dilution or concentration of globulin solutions and precipitation with ammonium sulphate, points representing analyses of the liquid phase fall on the curve found with the original solution, or in a special case coincide with a point previously found. Lines passing through these points and those representing the mixture from which the phases separate indicate that these phases are the same as those separating from the stock solution. Thus the equilibria were found to be reproducible and the applicability of the phase rule established. In the case of the globulin form which separates on dialysis, resolution and precipitation gave points falling below the curve mentioned above. This we suggested was probably due to aggregation of the particles brought about, perhaps, by surface denaturation of the protein during dialysis. It appears that globulin solutions, euglobulin and pseudoglobulin are but three phases of a system of the same mother substance, dehydrated globulin, solutions of globulin being the ordinary isotropic solutions, while euglobulin and pseudoglobulin are liquid crystalline phases or a liquid and glass which are slightly doubly refracting.

The heat of formation of water:[1] FREDERICK D. ROSSINI (introduced by George K. Burgess). The usually accepted value for the heat of formation of water is based upon measurements made by Thomsen in 1873, Schuller and Wartha in 1877 and Mixter in 1903. The most accurate and precise of these data are those of Schuller and Wartha, whose average value has an uncertainty of nearly 0.1 per cent., practically all of which lies in the calibration factor of their calorimeter. The procedure employed in the present investigation was to determine directly the quantitative correspondence between (1) the energy liberated when hydrogen and oxygen combine to form a weighed mass of H_2O and (2) a measured quantity of electrical energy, by using the calorimeter as the absorber of the two energy quantities and its temperature rise as the comparator. In so far as systematic errors are concerned, the absolute accuracy depends only upon the determination of the mass of water formed, in grams, and of the quantity of electrical energy, in terms of the mean solar second and the international volt and international ohm. High precision is obtained by the use of proper calorimetric technique, a sensitive device for measuring changes of temperature, a sensitive potentiometric system for measuring the electrical power input, a precision timing device and a suitable balance for weighing the H_2O formed. The data of two sets of nine experiments each give 285,775 international joules per mole (18.0156 g) for the heat of formation of liquid H_2O at 25° C., 1 atm. With the factors 1.0004 and (1.0004/4.185), this is equivalent to 285,890 absolute joules or 68,313 g-cal_{15}. The maximum and the average deviations, in percentages, are, respectively: 0.031 and 0.019 in Set I; 0.024 and 0.010 in Set II. The data of Schuller and Wartha, Thomsen and Mixter were recomputed in terms of the international joule. Their average values plus or minus the assigned errors are entirely concordant with the value obtained in this investigation.

[1] Published by permission of the director of the Bureau of Standards, Department of Commerce, Washington, D. C.

Diffusion of electrolytes and of colloids in aqueous solution: T. H. LIU and J. W. MCBAIN (introduced by W. C. Bray). By standardizing the procedure in the Northrop method of confining the diffusion gradient within a coarsely porous diaphragm, diffusion coefficients are easily obtainable which are reproducible within a fraction of a per cent. They agree well with the few good results which the laborious classical methods have hitherto produced but they permit of far closer scrutiny as to the effects of such factors as concentration. Substances in mixtures do not diffuse independently but may accelerate, retard or even reverse the diffusion of another and an action may be set up resembling that in a gaseous diffusion pump. Diffusion data point to incomplete dissociation of electrolytes, and the Nernst equation for a diffusion at infinite dilution is extended to cover high concentrations of potassium chloride. Other applications are to cadmium iodide with its complex ions and to constituents of soap solutions as colloidal electrolytes.

(To be continued)

BOOKS RECEIVED

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GUDGER, EUGENE W. *The Candirú, the only Vertebrate Parasite of Man.* Pp. xvii + 120. 18 illustrations. Hoeber. $1.50.

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PARSONS, ROBERT P. *History of Haitian Medicine.* Pp. xxviii + 196. 21 illustrations. Hoeber. $2.25.

RIGG, GEORGE B. *College Botany.* Pp. xviii + 442. 157 illustrations. Lea & Febiger. $4.00.

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WOOD, A. B. *A Text-book of Sound.* Pp. xiv + 519. 156 figures. Macmillan. $6.50.

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A STATE EXPERIMENT IN CHEMICAL RESEARCH[1]

By Professor G. T. MORGAN, F.R.S.

SUPERINTENDENT OF THE CHEMICAL RESEARCH LABORATORY, DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

AT the Bristol meeting of 1875 my predecessor, Professor A. G. Vernon Harcourt, spoke to this section on the teaching of chemistry, and in the course of his very inspiring address he remarked that "the science of chemistry would advance more rapidly if it were possible to organize chemists into working parties having each a definite region to explore," and he went on to inquire, "Is such an organization in any degree possible?"

I propose this morning to describe the attempt recently made by a department of state, namely, the Department of Scientific and Industrial Research, to give effect to Professor Vernon Harcourt's prophetic vision. The answer to his question is in the affirmative. Such an organization is in some degree possible, and has actually become an accomplished fact. I must, however, leave for one of my successors in this chair the further inquiry, "Can such an organization become permanent and still retain its primary and paramount function of chemical exploration?"

ORIGIN OF THE CHEMICAL RESEARCH LABORATORY

The work of the Department of Scientific and Industrial Research began in 1915, and during the ensuing ten years the department had at various times become interested in investigations of a chemical nature, such, for example, as (1) large-scale researches on the chlorination of methane; (2) large-scale researches on the production of formaldehyde, (3) investigations on the production of glycerine, (4) investigations on the manufacture of chemical products from fish residues, (5) general researches on the corrosion of metals, (6) general researches on high-pressure reactions, including the reactions between carbon monoxide and hydrogen.

These investigations, which were undertaken mainly

[1] Address of the president of Section B—Chemistry, British Association for the Advancement of Science, Bristol, September, 1930.

under the auspices of the Chemistry Coordinating Research Board, were carried out by isolated groups of workers, who were often located in widely separated laboratories. One group studied the corrosion of metals at the Royal School of Mines, another examined fish products in the Imperial College of Science and Technology, whereas a third experimented on the chlorination of methane and on the recovery of formaldehyde from waste liquors of wool-scouring at the Royal Naval Cordite Factory in Dorsetshire.

It soon became evident that some increase in economy and efficiency could be attained by bringing together under one roof these scattered groups of workers who would receive encouragement and stimulus by becoming part of a more centralized scientific organization.

A suitable site was chosen on the Bushy Park Estate in close proximity to the National Physical Laboratory and the Admiralty Research Laboratory, and here in 1924 the building of a chemical laboratory was commenced on a plot of land allowing ample scope for future expansion.

The original plans drawn out by the architects of H.M. Office of Works made provision for three laboratory units each of rectangular shape and built round four sides of a central courtyard. The front and back of the hollow rectangle consist of two two-story blocks; the front block designed for general and special small scale laboratories with the necessary offices, the back block arranged to accommodate workshops, service rooms and heating plant. The two sides of the rectangle, which consist of two single-story blocks with saw-toothed roofs, north lighted and with a clear head room of about sixteen feet, give adequate space for large-scale laboratories.

These buildings are constructed in steel and brick and so arranged that partitions can be readily removed for alterations or extensions. In the two-story blocks the floors and roofs are formed of hollow concrete tubes, but in the engineering section of the building, where heavy superloading had to be considered, a more rigid type of construction in steel and concrete floors was adopted. In the interest of economy, plaster and other relatively expensive internal finishings were omitted wherever possible, any distemper or paint being applied to flush-pointed brickwork. The floors were covered with stout cork carpet, laid directly on the cement rendering.

The laboratories are equipped with specially designed fittings, the framing and fronts are of stained British Columbia pine, whereas the bench tops and other portions subjected to hard wear are in teak or Iroko wood. The internal drainage to laboratory sinks is effected by open stone-ware three quarter circular channels finished with acid-resisting glaze. Wherever exposed internally, structural steel and joiners' work are coated with acid-resisting paint. The benches of small scale and special laboratories carry five services—gas, water, steam, vacuum and compressed air. Each room is amply supplied with electric current (D.C.).

In conformity with the neighboring buildings of the National Physical Laboratory, a simple modern Georgian style was adopted in the design of the elevations of the new laboratory. The buildings are faced externally with multi-stone sand face bricks, reconstructed Portland stone being used sparingly in cornices, string courses and entrance doorways.

The construction of one of these units was started towards the end of 1924, and when scientific work was commenced in the autumn of 1925 about one third of the first unit had been built, although actually only one room was ready for occupation. The fitting of the remaining laboratories and workshop was, however, rapidly effected, and by the end of 1926 the whole of the available space was fully occupied, the staff then consisting of the superintendent and ten chemists, with one engineering assistant and ten members of the artisan, clerical and general staff.

The frontage to the half unit was commenced in November, 1927, and completed for occupation by Easter, 1928, and the staff was then increased gradually to its present total strength of about sixty.

Beyond a small addition for stores and workrooms completed in 1929 there has been no further extension of the building, so that after five years rather more than half of the first unit has been erected and put into commission. There has been no attempt to force the growth of this state laboratory, which is still to be regarded as being at an experimental stage.

Administration and Control

The work of the laboratory is conducted under the guidance of a Chemistry Research Board, which has taken over certain functions of the older Chemistry Coordinating Research Board. This board is charged with the duty of advising the department on the program of work to be undertaken at the laboratory and of exercising general supervision over its execution.

At the outset executive control was exercised by a part-time director of chemical research and a whole-time superintendent, but from 1927 to the present this responsibility has been vested in a whole-time director.

Program of Research

At the present time the scientific and technical staffs are occupied on six specific items of research prescribed on the advice of the Chemistry Research Board, and "working parties of exploration" are detailed to these mandated researches by the director.

Now since these explorations were started at different times and in various circumstances, I propose to describe them simply in the order in which they have come under my notice. This arrangement is purely chronological, and has no bearing whatsoever on any order of merit or importance. Moreover it is essential to success in any research laboratory that each researcher should regard his own investigations as the most interesting and important in the world.

When thus arranged, the six mandated researches are as follows: synthetic resins, low temperature tar, high-pressure chemistry, corrosion of metals, chemotherapy and research on water pollution. In addition to these prescribed investigations a certain amount of general research is carried out at the discretion of the director.

SYNTHETIC RESINS

The growing importance of synthetic resins in chemical industry is gauged by the fact that the world's production of formaldehyde resins which was of the order of 9,000 tons in 1921 had increased to 13,000 tons in 1926, of which Great Britain was responsible for 16 per cent. as against 40, 24 and 8 per cent. derived respectively from the United States, Germany and France, other countries accounting for the remaining 12 per cent. Such resins are employed in the manufacture of moulding powders and electrical components. The production by industrially available means of resins of high dielectric capacity is a matter of national importance, and it was with this objective that an investigation of phenol-formaldehyde resins was begun even before the central laboratory was ready for occupation.

In May, 1925, a chemist was appointed to work at this problem in the University of Birmingham, and attention was directed to formaldehyde condensations with homologues of phenol, namely, the cresols and xylenols. Experience soon showed that *m*-cresol and 1:3:5-xylenol were especially suitable for such condensations which in the case of the former phenol were extended to a semi-works scale.

According to the nature of the catalyst employed, phenol-formaldehyde condensations yield, in general, one or other of two distinct types of resin. Alkaline catalysts lead to the production of resins of "bakelite" type, which, although originally soluble and fusible, yet possess the property of moulding under the combined effect of heat and pressure into hard insoluble and infusible products constituting by far the more important group of phenol-formaldehyde resins.

Acid catalysts favor the production of resins of "novolak" type, which, being permanently soluble and fusible, are utilized principally as shellac substitutes in lacquers and varnishes.

Alkaline Condensations: After successful small-scale tests, alkaline condensations of formaldehyde were performed on twenty-four pounds of *m*-cresol, carried out under factory conditions in a plant of semi-works scale comprising a jacketed reaction vessel, reflux condensers, washing and storage tanks, drying and incorporating vessels and a hydraulic press with heated platens.

A systematic study of this alkaline condensation revealed the presence of several crystalline intermediates which precede the formation of resin. The latter was employed in the production of moulded articles and of laminated boards for electrical testing.

Acidic Condensations: The chemical nature of formaldehyde-phenolic resins is still a matter of speculation, but the appearance of crystalline intermediates in the early stages of acidic condensations is of interest as denoting the course of these reactions. During these researches several crystalline intermediate products were isolated for the first time.

FORMALDEHYDE-KETONE RESINS

In the foregoing formaldehyde-phenol condensations, acetone is sometimes used as a medium, but since in the presence of alkalis this solvent condenses with formaldehyde to yield resins, the chemistry of the process has been elucidated by a study of the interaction of formaldehyde and the ketones under alkaline conditions. As the homologous series is ascended the formation of resin decreases. Acetone yields mainly resin and small proportions of γ-ketobutanol, $CH_3 \cdot CO \cdot CH_2 \cdot CH_2 \cdot OH$ and of the tetrahydropyrone formed by dehydration of the tetrahydric alcohol $HO \cdot CH_2 \cdot CH_2 \cdot CO \cdot C(CH_2 \cdot OH)_3$. Methyl ethyl ketone gives considerable proportions of the following mono- and di-hydric alcohols, $CH_3 \cdot CO \cdot CH(CH_2 \cdot OH) \cdot CH_3$ and $CH_3 \cdot CO \cdot C(CH_2 \cdot OH)_2 \cdot CH_3$ with but little resin. Diethyl ketone furnishes no resin but leads to similar mono-, di- and tri-hydric alcohols.

LOW TEMPERATURE TAR

There is at the present time in this country no process of chemical industry which is more in the public eye than low temperature carbonization of coal. The matter is of supreme national importance, for the larger problems facing this mode of utilizing coal are both economic and technical and turn on the exploitation to the best advantage of the resulting products: smokeless fuel, gas, aqueous liquor and tar. Now since any marked appreciation can be expected only in the case of the last of these products it follows that processes tending to an increase in the value of the tar are of fundamental interest.

During the last five years a systematic study of the chemical constituents of low temperature tar has been in progress in the Teddington laboratory and, in our

experiments on this material, quantities of the order of 40 gallons have been handled in the semi-scale plant. The starting materials, supplied by H.M. Fuel Research Station as part of the government's scheme of scientific investigation into the utilization of our national resources of coal, consist of pedigree tars derived from coals of definite origin carbonized under carefully controlled and reproducible conditions.

It was soon found that although low temperature tar had been produced at carbonizing temperatures of about 600°, yet it could not again be heated even to comparatively low temperatures—round about 150°—without undergoing considerable alterations of a chemical nature. Accordingly, distillation processes were replaced by milder methods of extraction, and the tar was not heated above 120° until its more decomposable constituents had been removed.

A representative tar from a typical bituminous coal (Kinneil coal) was heated to 120° to remove light oils and adhering aqueous liquor, and the residue extracted by systematic use of solvents to separate it into its major constituents: neutral oils and waxes, aromatic hydrocarbons, bases, phenols and carboxylic acids. It was then noticed that each of these five main groups of products could be separated into two fractions, one portion consisting of crystallizable substances conveniently termed "crystalloids," the other portion composed of amorphous resinous materials to which the name "resinoids" was applied.

THE CRYSTALLOIDS OF TAR

Waxes and Neutral Oils: From the least volatile fractions of neutral oils, waxes are obtained melting over a considerable range of temperature, and X-ray analysis of the less fusible of these waxes has revealed the presence of hydrocarbon chains containing 26, 27 and 29 carbon atoms.

The neutral oils contain both saturated and unsaturated hydrocarbons and also oxygenated substances reacting with ferrichloric acid, $HFeCl_4$.

Aromatic Hydrocarbons: Naphthalene, a characteristic major constituent of high temperature tar, is present in low temperature tar, together with β-methylnaphthalene, but only in such small proportions that they have to be separated through their picrates.

The least volatile tar oils after removal of waxes and resins deposit on cooling a material analogous to the green grease of high temperature tar. This product consists principally of the methyl derivatives of anthracene, although a small proportion of this hydrocarbon itself may possibly be present. Oxidation of various fractions from this product leads to 2-methylanthraquinone, 2:6- and 2:7-dimethylanthraquinone and 2:3:6-trimethylanthraquinone. The proof of the orientation of methyl groups in these anthracene derivatives has involved the synthesis of the hydrocarbons and of their quinones.[2]

Bases: The volatile bases of low temperature tar are mainly tertiary amines although a small amount of aniline was detected. The following bases were isolated and purified through their crystalline mercurichlorides: pyridine, α-picoline, 2:4- and 2:6-lutidines and symmetrical collidine; quinoline and quinaldine were isolated as picrates.

Phenols: Low temperature tars contain a high proportion of material extractable with aqueous caustic soda, but only a portion of this soluble extract consists of true phenols, the remainder is composed of non-phenolic substances which, however, dissolve in solutions of the alkaline phenolates. These non-phenolic materials are recovered from a caustic soda extract of the tar either by agitation with an organic solvent such as chloroform or more simply by saturating the alkaline extract with salt. The true phenols remaining in the alkaline solution are separated into crystalline and resinous portions by solution of the former in light petroleum. Further fractionation of the petroleum soluble phenols has led to the isolation of the following compounds: phenol, the three cresols and five of the six possible xylenols. Bacteriological examination of the phenols of low temperature tar has shown that their germicidal value increases with rise of boiling point to an optimum fraction boiling at 140–170° under 5 mm pressure. Moreover, it has been found that direct chlorination of these higher phenols of low temperature tar increases considerably their germicidal potency.

THE RESINOIDS OF TAR

With each class of crystalloid in the low temperature tar there is present a corresponding resinoid which constitutes the least volatile portion of each major fraction. These products, which are termed respectively resinenes (neutral resins), resinamines (basic resins), resinols (phenolic resins) and resinoic acids (acidic resins), are obtained as amorphous powders after extraction of the corresponding crystalloids with petroleum or other suitable solvent. These resinous tar products are promising materials for further research from both scientific and industrial view-points.

An extension of the solvent method of extraction to other varieties of tar from wood, peat, lignite and bituminous coal has revealed the presence in each tar of the four classes of resins, although in wood tars the amount of resinamines was very small. Coal tars produced by carbonization at high and at intermediate

[2] *Journ. Chem. Soc.*, 1929, 2203 and 2551.

temperatures show considerable variations in their resin contents.

AQUEOUS LIQUORS OF COAL CARBONIZATION

The aqueous liquors which accompany low temperature tars have been extracted systematically with organic solvents in quantities of 30 gallons at a time, and in this way phenol, *o*-cresol, catechol and its two methyl derivatives, resorcinol and quinol, have been isolated, together with a new type of resins to which the name resinolic acids has been given, as they are intermediate in chemical properties between resinols and resinoic acids. Resinolic acids in the presence of ammonia are largely responsible for the dark red color of the aqueous effluents from gasworks. These aqueous liquors have also furnished on systematic extraction aniline, pyridine and α-picoline, and the series of fatty acids ranging from formic to *n*-valeric acids.

HIGH PRESSURE CHEMISTRY

During the past ten years increasing attention has been directed to the use of pressure as a means of facilitating the course of chemical reactions, and research on high pressure syntheses was started at the laboratory in 1926 on the recommendation of the Chemistry Coordinating Research Board, whose members were impressed by the possibilities revealed by the work of Patart in France and of the Badische Anilin und Soda Fabrik in Germany.

The plant required for this investigation was designed and built in the laboratory workshop, and the earliest experiments were carried out with hand compressors. Subsequently motor-driven compressors and circulators were added to the equipment. This plant was first tried out with catalysts of the Patart type (normal or basic zinc chromate) in order to gain skill and confidence in the process. It was thus found that on passing the mixed gases (1 vol. CO, 2 vols. H_2) at the rate of 30,000 vols. per hour, measured at N.T.P. over unit volume of such a catalyst at 380° and under 200 atmospheres' pressure the hourly production of methyl alcohol was about twice the volume of catalyst space.

The addition of cobalt chromate or nitrate to the foregoing zinc chromate catalyst led to an interesting development, since with the more complex catalyst ethyl alcohol and other higher alcohols made their appearance, although methyl alcohol remained the predominant product. Small amounts of aldehydes and acids were also detected. By the use of mixed cobalt catalysts containing zinc, together with chromium or manganese, the following alcohols have been obtained in addition to methyl and ethyl alcohols: *n*-propyl, *n*-butyl, *iso*-butyl and *n*-amyl alcohols and racemoid 1-methyl-propylcarbinol $CH_3 \cdot CH_2 \cdot CH(CH_3) \cdot CH_2 \cdot OH$. So far only primary alcohols have been detected. Aldehydic products have been identified as follows: formaldehyde, acetaldehyde, propaldehyde, *n*-butaldehyde and also certain aldehydals arising from the condensation of the foregoing aldehydes and alcohols. Moreover, the synthetic products contain formic, acetic, propionic and *n*-butyric acids.

The addition of even small proportions of cobalt to copper-manganese oxide catalysts (Audibert type) has a marked effect on the production of ethyl alcohol and its homologues, and a similar result is noticed on replacing the cobalt in these catalysts by iron. Traces of alkali hydroxide promote the formation of higher alcohols, and in this respect potash is more efficacious than lithia.

HELIUM FROM MONAZITE SAND

In addition to their synthetic experiments, the staff engaged on high pressure chemistry have brought to completion a research on the extraction of helium from the monazite sand conveyed to this country from Travancore for the manufacture of thoria and ceria required in the incandescent mantle industry. During this manufacture each gram of sand evolves 1 cc of helium at N.T.P., so that 100 tons of sand would discharge into the atmosphere approximately 100,000 liters of the gas. Our requirements of this raw material were entirely met through the kind assistance of the late Mr. Edmund White, formerly managing director of Messrs. Thorium, Limited.

The gas was liberated by heating the monazite at 1000° in heat-resisting steel pots in a stream of carbon dioxide, and the issuing gas was passed over cupric oxide at 500° to oxidize hydrogen and carbon monoxide. Carbon dioxide was then removed by aqueous caustic soda and the residual gas passed over metallic magnesium at 600° in order to remove nitrogen and over metallic calcium at 580° to eliminate the remaining impurities. Several hundredweights of sand were thus treated and returned to Messrs. Thorium, Limited, who found that they could still employ the heated material in their process providing that it was mixed with a certain proportion of raw sand. The purified gas containing 99.5 per cent. of helium was compressed into storage cylinders.

CORROSION RESEARCH

The researches on corrosion were originally started by a committee of the Institute of Metals in 1916, and after eight years the more scientific developments of these problems were undertaken by the Corrosion Research Committee of the Department of Scientific and Industrial Research, this work being pursued in the metallurgical department of the Royal School of

Mines until the workers concerned were transferred to Teddington at Easter, 1928.

CORROSION OF IMMERSED METALS

Research on the corrosion of immersed metals has been concentrated on an attempt to put the theory of this phenomenon on a secure quantitative foundation. For although earlier work in this country and in the United States had furnished a qualitative explanation of corrosive action in water or in salt solutions, yet this description of the process postulated the influence of more than a dozen factors on the corrosive rates of immersed metals. Accordingly, one aim of the present research is to acquire precise information as to the interaction of these factors, and another objective is to ascertain whether the lack of reproducibility in corrosion experiments is inherent in the corrosion process itself or whether it is due to imperfect regulation of all variables. Among these factors are purity of materials: metal, water, salt and atmosphere, constancy of temperature and pressure, and freedom from mechanical agitation. Zinc of a purity of 99.99 per cent., distilled water with an electrical conductivity of 0.058 gemmhos at 20° and purified oxygen were employed, and all experiments were carried out at 25° within a temperature range of ± 0.02° over long periods of time, sometimes for upwards of six months.

Measurements of oxygen absorbed, corrected for any hydrogen evolved, made at frequent intervals during the course of such experiments have enabled one to plot continuous corrosion time curves which are often sufficiently smooth and regular to be investigated mathematically.

The apparatus employed for this purpose is shown among the exhibits from the laboratory. Originally designed for zinc it is now being used extensively for work on iron and steel.

Oxygen passes through water or salt solutions to the immersed metal either by diffusion or convection, but the latter mode of transference is by far the more effective at more than very shallow depths. Convection currents may arise in a salt solution owing to four different causes: (1) temperature changes, (2) density changes produced by evaporation at the surface layer, (3) density changes produced by differences of oxygen concentration, (4) mechanical agitation. The apparatus employed for these quantitative experiments is immersed in a thermostat and corrosion occurs in a closed space within it so that the effects of temperature changes (1) and evaporation (2) are practically negligible, and special precautions are taken to prevent agitation (4). Accordingly, by removing oxygen from the neighborhood of the metal, the corrosion process produces convection currents of the third category due to changes in concentration of oxygen. The velocity of these convection currents depends on the difference in density between the solution saturated with oxygen at the liquid surface and the solution next to the metal. Assuming that the latter solution contains very little oxygen, the velocity of convection will probably be proportional to the solubility of oxygen in the liquid, but the amount of oxygen carried by the current is also proportional to its solubility. Hence, the rate of corrosion (y) should be proportional to the square of the oxygen solubility (x), a relation which is expressible by the equation $y = kx^2$. This assumption has been verified for on plotting the observed rates of corrosion against oxygen solubility one obtains curves of parabolic form.

Hydrogen evolution due to the interaction of water or salt solution with metals such as zinc or steel is of greater importance than is generally supposed. Determinations of the hydrogen liberated during zinc corrosion have shown that a very small amount of impurity has a considerable influence on the amount of gas evolved. In N/10,000 potassium chloride measurable quantities of hydrogen are obtained from 99.99 per cent. zinc, whereas no hydrogen was detected from zinc of spectroscopic purity. The proportion of zinc corrosion due to evolution of hydrogen increases with concentration of potassium chloride, and with 2N-solutions it amounts to 17.4 per cent. of the total corrosion.

When all the foregoing factors are taken into account, successive corrosion experiments exhibit a high degree of reproducibility and the curves indicate that duplicates differ from their mean value by 1 per cent. or even less. This constancy indicates that the corrosion of zinc and allied metals is not inherently erratic, but is quite a suitable subject for physico-chemical investigations.

ATMOSPHERIC CORROSION

Investigations of various types of indoor and open-air corrosion and of protective oxide films, previously conducted under the auspices of the Atmospheric Corrosion Research Committee of the British Non-ferrous Metals Research Association, were taken over by the Department of Scientific and Industrial Research in July, 1927. This work was continued at the Royal School of Mines until April, 1928, when the corrosion section was transferred to the Chemical Research Laboratory. The more outstanding results since obtained are as follows:

Composition of Green Patina on Copper Structures: Samples of the familiar green patina on exposed copper surfaces, obtained from typical localities, town, country, marine and urban-marine, were analyzed completely. Contrary to the general belief, basic copper carbonate was found to be not the prin-

cipal but only a minor constituent of the green patina. With the exception of the product from a purely marine atmosphere in which basic copper chloride predominated, the major constituent throughout was basic copper sulphate, and excess of basic sulphate over basic carbonate was greater in the rural than in the urban samples. Where urban and marine conditions coincided, basic sulphate predominated greatly over both basic chloride and basic carbonate.

It has recently been found that these constituents of the green patina tend to assume the chemical composition of the corresponding green copper minerals. In the limits, the basic copper sulphate of corrosion coincides in composition with brochantite of which the coordination formula is $[Cu\{(HO)_2Cu\}_3]SO_4$, and the basic copper chloride of corrosion with atacamite $[Cu\{(HO)_2Cu\}_3]Cl_2$. Basic copper carbonate on the other hand tends to assume the composition of malachite $[Cu\{(HO)_2Cu\}]CO_3$. Complete agreement with the composition required by the coordination theory has been realized in corrosion products after 70 years' exposure and upwards. After shorter periods of exposure the basicity of the product is in a lower ratio than that of the corresponding minerals.

The complete analysis of these corrosion products entailed special precautions. The carbonates were decomposed by phosphoric acid instead of hydrochloric or sulphuric acid, and any hydrogen chloride and hydrogen sulphide simultaneously set free were eliminated by *p*-nitrosodimethylaniline and copper powder respectively.

Corrosion of Magnesium Alloys: The growing use of light magnesium alloys for motor-car and aircraft work has necessitated increased attention to the corrosive properties of these metals. In 1929 a research was begun with the object of discovering improved methods of protection and of learning more about the nature of the corrosion. More than 500 different protective coatings have been produced by chemical means and tested for resistance to sea-water sprays. Of these coatings a few are sufficiently promising to warrant further study.

CHEMOTHERAPY

In 1927 a joint exploratory committee of the Department of Scientific and Industrial Research and of the Medical Research Council decided that there was need for organized research in chemotherapy, and accordingly the Medical Research Council set up a permanent committee to advise them on investigations in this field. To this committee the department has nominated three chemical members, including the director of chemical research, and facilities have been afforded by the department for a staff of three chemists to work on problems based on an agreed program. These chemists have already prepared a considerable number of organic compounds of possible utility in chemotherapy and these are being tested systematically under arrangements made by the permanent committee. This work of national importance is a joint effort of several groups of chemists working in different laboratories, so that a wide and thorough search for greatly needed drugs and therapeutic agents is in progress.

The Teddington contribution to these researches may be classified under the two following main headings:

1. *Analogues of Bayer 205 or Fourneau 309:* Last year in his presidential address to the physiology section of the British Association in South Africa, Professor W. E. Dixon referred to the serious ravages produced in that continent by sleeping sickness (trypanosomiasis), and his admirable survey of the position from the view-point of chemotherapy renders unnecessary any further elaboration of that aspect of the problem in the present summary.

The activity of medicaments of the Bayer 205 or Fourneau 309 type may depend more on the aggregate effect of the whole molecule rather than on the presence in the molecule of any particular group or arrangement. In this, as in other cases, there are no definite laws connecting therapeutic activity and chemical structure.

Compounds have been prepared in which the terminal aminonaphthalenedisulphonic radicals have been replaced by analogous complexes derived from aminocarbazole di- and tri-sulphonic acids or from the disulphonic acids of aminofluorene and of aminofluorenone, but so far the effect of this substitution has not been encouraging. The possibility of a beneficial introduction of arsenic into the fluorene nucleus has, however, been considered, and experiment has shown that trypanocidal activity is manifested when an arsinic acid radical is present in a fluorene molecule in conjunction with an amino-group.

2. *Organic Derivatives of Arsenic and Antimony:* During many years organic arsenicals have received much attention, whereas organic antimonials have not been subjected to the same careful scrutiny, partly owing to the fact that they are more difficult to prepare in a state of purity and partly because the curative results have been less promising.

Nevertheless, since antimony in organic combination appears to possess specific trypanocidal activity and some curative action in kala-azar, experiments have been made in the Teddington laboratory on the preparation of antimony analogues of the more successful arsenicals. Tryparsamide (phenylglycine-amido-*p*-arsinic acid) is used extensively in treating trypanosomiasis, and its antimony analogue has been under

examination. In the more stable meta series, phenylglycine-amido-*m*-stibinic acid and certain allied compounds show a slight trypanocidal effect. The antimony analogue of stovarsol (3-acetylamino-4-hydroxyphenyl arsinic acid) or more probably its internal dehydration product has also exhibited some therapeutic activity.

Concurrently with this study of organic antimonials further experiments have been made on organic arsenicals produced by condensing atoxyl successively with succinic anhydride, and with a base such as ammonia, methylamine, dimethylamine, piperidine or aniline. Certain of these derivatives have also exhibited a definite action on trypanosomes.

In addition to the preparation of antimonials directly applicable to therapeutic tests, our knowledge of the organic chemistry of antimony has been extended among aliphatic derivatives by the production of antimony analogues of the cacodyl group and in the aromatic series by the synthesis of cyclic antimonials analogous to the alkyl- and aryl-carbazoles.

WATER POLLUTION RESEARCH

This research originated from a joint request made to the Department of Scientific and Industrial Research by the Ministry of Health and the Ministry of Agriculture and Fisheries.

During the past two years, experiments have been in progress under the auspices of the Water Pollution Research Board on the base-exchange method of water softening. One of the objects of this work has been to determine the most satisfactory way of carrying out the process, such points having been examined as the effect of varying the rate of flow of water through the bed of base-exchange material and the quantity, concentration and time of contact of the salt solution used in regenerating this material. There are two types of base-exchange material in actual industrial use, treated minerals and synthetic products prepared by interaction of solutions of sodium aluminate and sodium silicate. It appears from the result of the Teddington experiments that with treated minerals the exchange of bases is confined to the outer surface of the particles whereas with the synthetic materials diffusion to the inner surfaces or into the mass of the gel is an important factor. This study of the base-exchange process has also been extended to the case of waters rich in magnesium.

Disintegration of the base-exchange materials and contamination of the softened waters by silica and alumina have been investigated. At the rate of flow employed normally in water softening, the silica content of the water is not increased seriously and is certainly not greater than that often encountered in untreated waters.

In addition to this practical work a report summarizing existing knowledge of the base-exchange or zeolite process for water softening has been compiled and published.

GENERAL RESEARCH

Investigation of complex aromatic hydrocarbons: In 1926 the dyestuffs industry development committee of the Board of Trade suggested that further fundamental research was desirable on the following coal tar products: acenaphthene, carbazole, fluorene, perylene and phenanthrene. Two of these suggestions were adopted and, with the assistance of two chemists, the director, who is also a member of this statutory committee, undertook a study of acenaphthene and perylene, the work being continued until 1928. During this period considerable progress was made with the former hydrocarbon, the nitration of which was studied under anhydrous and hydrous conditions. For nitrations, in the absence of water, diacetylorthonitric acid and benzoyl nitrate were employed, the latter being a reagent discovered originally in 1906 by Professor Francis, of this university. Several new nitro derivatives were identified, and 2-aminoacenaphthene and 2-acenaphthenol (2-hydroxyacenaphthene) were prepared for the first time.

Higher Fatty Acids: In order to identify the waxes isolated from low temperature tar a parallel research was made on the synthesis of individual waxes from the higher fatty acids. Those waxes containing an even number of carbon atoms were produced electrolytically by Kolbe's classical synthesis (1849), whereas their homologues containing odd numbers of carbon atoms were prepared by a more modern process due to Grün, Ulbrich and Krczil (1926). By these complementary processes individual waxes containing 27, 30 and 34 carbon atoms were prepared for comparative purposes. This inquiry necessitated the study of several higher fatty acids, including arachidic acid, and in such cases analytical data were confirmed by X-ray analyses carried out in the National Physical Laboratory.

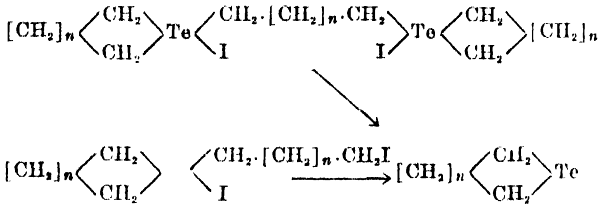
Cyclic systems containing selenium and tellurium: Considerable progress has been made in the study of heterocyclic systems containing selenium or tellurium atoms. The selenium series has been prepared by a general method, the interaction of alkylene bromides and sodium selenide in an inert atmosphere.

$$[CH_2]_n \left\langle \begin{matrix} CH_2 \cdot Br \\ CH_2 \cdot Br \end{matrix} \right. + Na_2Se = [CH_2]_n \left\langle \begin{matrix} CH_2 \\ CH_2 \end{matrix} \right\rangle Se + 2NaBr$$
$$n = 1, 2, 3, \text{ or } 4.$$

In this way the cyclic selenohydrocarbons with $n = 1$, 2, 3 or 4 have been obtained for the first time. The five-membered ring, *cyclo*selenobutane (tetrahydro-

selenophen) and its next homologue, *cyclo*selenopentane, are formed by the foregoing reaction with considerable facility, but the four-and seven-membered rings show signs of instability, and in their production complex solid polymerides make their appearance.

In the tellurium series the corresponding cyclic derivatives are conveniently prepared by the action of aluminium telluride on alkylene halides. This process leads to the production of cyclic systems containing quadrivalent tellurium.



$n = 1, 2,$ or 3.

From the foregoing complex telluronium iodides the cyclic tellurohydrocarbon is obtained by thermal dissociation under reduced pressure. By such means *cyclo*tellurobutane and *cyclo*telluropentane have been isolated and some evidence was obtained of the existence of a four-membered ring.

Aromatic selenium and tellurium compounds: Phenol and the cresols have been condensed with selenium oxychloride when two types of seleniferous products have been distinguished, polar salt-like substances (Formula I) and non-polar selenides (Formula II).

$$\text{I } [(HO \cdot C_6H_4)_3Se]Cl \qquad Se(C_7H_6 \cdot OH)_2 \text{ II}$$

When the cresols were condensed with basic tellurium chloride the following types were distinguished, all containing quadrivalent tellurium: $HO \cdot C_7H_6 \cdot TeCl_3$, $(HOC_7H_6)_2TeCl_2$, $(HOC_7H_6)_3TeCl$. The more soluble of such selenium and tellurium compounds have been tested on trypanosomes, but so far no evidence of activity has been discerned.

Studies in the Diphenyl Series: The *o*-xenylamine required in the synthesis of cyclic antimonials was formerly obtained in a somewhat tedious manner by the pyrolysis of diazoaminobenzene. This base has now been prepared by a method practicable on a large scale from commercially obtainable diphenyl.

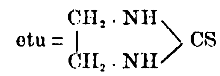
o-Xenylamine and its homologues, for example, 4′:5-dimethyl-*o*-xenylamine, are convenient starting-points for the synthesis of carbazole and phenanthridine derivatives.

Residual Affinity and Coordination

An experimental study of the effect of various coordinated addenda on the valencies of copper, silver and gold has been pursued during the past five years with the following results.

Stabilization of the cupric condition: In the absence of suitable addenda the cupric ion is unstable when in combination with less electronegative anions such as iodide, sulphite, thiosulphate, thiocyanate, selenocyanate and hypophosphite, but by coordinating this metallic ion with ethylenediamine ($en = NH_2 \cdot [CH_2]_2 \cdot NH_2$) stability is thereby conferred on the bivalent condition, and well-defined complex salts of the following types are obtained: $[Cu, 2en, 2H_2O]I_2$, $[Cu, 2en, R \cdot OH]\ I_2 (R = CH_3$ or $C_2H_5)$, $[Cu, 2en]X$ where $X = SO_3, S_2O_3, S_2O_6, S_3O_6$ or S_4O_6 and $[Cu, 2en]Y_2$ where $Y = CNS$, $CNSe$ or H_2PO_2. Moreover, the following stable normal salts $[Cu, 2en]\ CO_3, 2H_2O$, and $[Cu, 2en] (NO_2)_2$ are obtainable with carbonate and nitrite radicals respectively.

Stabilization of the cuprous condition: Even more noteworthy than the preceding effect of ethylenediamine is the influence of addenda containing sulphur on the stability of the cuprous ion. Cuprous sulphate, an endothermic compound, decomposes in water with generation of heat and loss of half its copper, $Cu_2SO_4 + 5Aq = CuSO_4, 5Aq + Cu$, but by coordinating the cuprous ion with ethylenethiocarbamide,



the univalent condition becomes stabilized even in combination with nitrate, sulphate and acetate radicals. The following colorless water-soluble salts have been identified: $[Cu, 4\ etu]NO_3$, $[Cu, 3\ etu]_2SO_4$ and $[Cu, 3\ etu]CH_3CO_2$.

Coordination compounds of silver: Since the silver ion is generally univalent, its coordination with ethylenethiocarbamide or other sulphur containing addenda does not involve any change of valency. It is, however, significant that $[Ag, 3\ etu]Cl$ is a water-soluble salt which remains colorless even after prolonged exposure to light.

A contribution to the chemistry of bivalent silver has been made by coordinating its ion with a-a'-dipyridyl (dipy), and the following colored salts have been isolated $[Ag, 2\ dipy]S_2O_8$ (chocolate brown), $[Ag, 2\ dipy](HSO_4)_2$ (dark brown plates) and $[Ag, 3\ dipy](ClO_3)_2$ crystallizing in well-defined, lustrous, black, acicular prisms.

Stabilization of the aurous condition: Coordination of gold salts with ethylenethiocarbamide has the same effect as with copper compounds. The fundamental univalency of the metallic ion becomes stabilized so that the following complex aurous salts have been identified: $[Au, 2\ etu]_2SO_4, 2H_2O$, $[Au, 2\ etu]NO_3$, $[Au, 2\ etu]Cl, H_2O$ and $[Au, 2\ etu]Br, H_2O$. These compounds are colorless and dissolve in water to prac-

tically neutral solutions (P_H value about 6·2). Conductivity experiments indicate that in dilute aqueous solutions these complex salts are highly ionized so that the complex radical [Au, 2 etu][1] plays the part of a compound alkali ion. The bromide of this series was mentioned last year by Professor W. E. Dixon (*loc. cit.*) as being a compound which had the effect of delaying death when administered to animals infected with bovine tuberculosis.

CHEMICAL ENGINEERING

The mainstay of the foregoing investigations are the well-equipped workshops manned by five skilled artisans who are engaged on the production and maintenance of the appliances and plant required in the various research programs. Appliances for high-pressure chemistry are a speciality of the laboratory workshops, and such plant includes bombs and pre-heaters for flow-through experiments with gaseous reagents, and autoclaves of various types for reactions with gases, liquids and solids. The researches on tar products call for automatic extractors, filter plant and stills operating under either ordinary or diminished pressures.

THE STATE LABORATORY AND THE SCIENTIFIC PUBLIC

The twofold primary aim of any state research laboratory should be the collection and dispersal of scientific knowledge and information. For the former function of collection and discovery of new knowledge the exploring parties foreseen by Professor Vernon Harcourt should supply an adequate means providing that each group proceeds under enlightened and inspired leadership. But for the complementary function of dispersal of information a chemical laboratory must depend largely on such well-established media of publication as the journals of the leading chemical societies. The greater part of the published research of the Teddington laboratory has appeared in the journals of the Chemical Society and of the Society of Chemical Industry, although a certain proportion has been published in the Proceedings of the Royal Society, *Journal of the Institute of Metals*, and Proceedings of the Institution of Chemical Engineers. Grateful recognition should be recorded for the generous aid afforded by all these learned societies, and special thanks are due to the first two mentioned. It is my personal opinion that this mode of dispersing chemical knowledge should have priority over its publication in official governmental reports. First, because in this way the information radiates more rapidly to a wider public; thus each of the two chemical journals just mentioned has more than 5,000 registered readers. Secondly, because this form of publication is frequently preceded by a reading and discussion of the subject-matter at a scientific meeting, and lastly because the financial circumstances of the learned societies compel them to impose a limit on the length of communications which is conducive to brevity and conciseness.

RELATIONS WITH OTHER SCIENTIFIC INSTITUTIONS

Apart from substances of therapeutic interest prepared for the committee on chemotherapy, numerous other research materials have been distributed to colleagues in the universities and research institutions. Compressed helium and carbon monoxide have been rendered available for scientific workers requiring these gases. Organic derivatives of tellurium have been lent to the Cambridge University Chemical Laboratory for the purpose of physico-chemical measurements, and to the Birkbeck College for the demonstration of the parachor of this element. Compounds of special chemical interest have been supplied to the Davy Faraday Laboratory and to the National Physical Laboratory for the X-ray study of their crystal structure. It is a pleasant duty to refer to the aid received from the Government Laboratory in respect of microanalyses and in connection with the work on synthetic resins.

Reference has already been made to the close collaboration of the laboratory with H.M. Fuel Research Station in regard to the products of coal carbonization. Certain preparations from low temperature tar have been submitted to the Cotton and Woollen Research Associations, for examination in connection with the chemical treatment of textile fibers.

RELATIONS WITH CHEMICAL INDUSTRY

The associations of the laboratory with chemical industry have always been cordial and are daily becoming increasingly intimate. Prominent industrialists either individually or in their corporate capacity as members of the Association of British Chemical Manufacturers and allied organizations have visited the laboratory and sometimes repeatedly.

Arising out of these visits and informal conferences, more than a hundred samples of the research products of the laboratory have been distributed to interested enquirers.

Members of the scientific staff participate in the work of the Committee for the Standardization of Tar Products Tests, the Bureau of Chemical Abstracts, the Corrosion Committee of the Iron and Steel Institute, and the Council and various Committees of the Society of Chemical Industry.

Although the laboratory is not a teaching institution in the academic sense of the term, yet facilities have been afforded for collaboration in research to chemists in training of approved qualifications. The

two leading metropolitan gas companies have seconded to the laboratory for this purpose junior members of their scientific staffs who have worked at Teddington for periods ranging from six to eighteen months. The subjects so far selected for this collaboration have been high-pressure chemistry and low temperature tar.

In the foregoing description of the activities of the new laboratory I have endeavored to speak as historian rather than as advocate, but if any justification is to be included I would take as the two leading points of my case: First, the scientific and industrial importance of the researches completed and in progress; secondly, the significant fact that of the sixteen members of the laboratory staff who have resigned during the five years, fourteen have gone into chemical industry to occupy positions of considerable importance and responsibility. The appreciation of chemical talent is a valuable function of this state laboratory.

ANTICIPATIONS AND CURRENT TENDENCIES

Those who feel sufficiently interested in the realization of Professor Vernon Harcourt's vision should not fail to visit the exhibit of laboratory products now on view in an adjacent room, for these specimens, diagrams, models and photographs furnish a record of the researches of this youthful organization which is far more realistic and appealing than any words of mine can be.

Certain of these investigations have an immediate practical objective; others represent the long view. It is, however, impossible to draw a definite distinction between these contrasted types. The aim of a state laboratory should rather be to encourage a judicious blend of the two.

The chemical preparations now selected for exhibition as representing the work of the first five years are only the more distinctive specimens of a much larger collection which is continually being accumulated and classified. In a similar orderly manner chemical knowledge is being collected and systematized in the files and card-indexes compiled by members of each exploring party. So soon as any particular research is sufficiently complete it is contributed to the appropriate learned society. Occasionally publication takes the form of patent specifications. By such concerted efforts the laboratory must come to be recognized as a storehouse of chemical information at least for those branches of the science which are included in the scope of its researches.

Is it desirable that this scope should be extended, and if so in what directions? This is not the occasion to discuss matters of departmental policy, but, in my present capacity, I may, like my predecessor of fifty-five years ago, indulge in anticipations of how future developments might be of advantage to chemical science in general and to British chemistry in particular.

INORGANIC AND MINERAL CHEMISTRY

An eminent authority has recently enquired what has become of inorganic chemistry and this question is frequently repeated. The present answer is that, so far as this country is concerned, the subject is no longer investigated systematically. British chemists are now for the most part content to leave this work of exploration to their contemporaries in other lands. Yet the British Empire is endowed with mineral resources to an extent unsurpassed by any other nation or empire under the sun. It can scarcely be contended that in this respect we are rendering an adequate account of our stewardship. Although there are a few meritorious exceptions, one may say broadly that there is no sustained British attempt to study the rare earths, the less common alkalis, or the metals of the platinum group. Such chemical curiosities as beryllium, gallium, germanium, indium and thallium rarely excite the scientific interest of our investigators. Yet the chemical study of the less common elements, and especially of those grouped under the disparaging term of "minor metals," is a matter of considerable scientific importance and one which sooner rather than later is likely to yield results of industrial value. If proof of this statement is needed, reference may be made to the inert gases which were first noticed in 1894 and subsequently found by Ramsay and Travers to be five in number. To-day three of these gases are employed industrially.

I have already mentioned low temperature tar which is literally a burning question. The great German combination of chemical factories—the Interessen Gemeinschaft—have recently filed patents describing the catalytic effect of molybdic acid on the hydrogenation under pressure of this intractable material. They claim a clear volatile product obtainable in good yield and suitable for motor fuel. Further investigation shows that this beneficial catalytic influence is peculiar to molybdenum compounds and is not possessed by analogous compounds of the other metals of the sixth periodic family. It certainly pays to study chemically the idiosyncrasies of the rarer elements and their derivatives.

THE ORGANIC CHEMISTRY OF VITAL PRODUCTS

At the Bristol meeting of 1898, Professor F. R. Japp's presidential address to this section dealt with the subjects of stereochemistry and vitalism. He called attention to nature's method of preparing single optically active substances, and referred to the insufficiency of the mechanical explanation of vitalistic phenomena.

Considerable advances have since been made in our knowledge of the fundamental process of photosynthesis, notably as the result of suggestive discoveries by Professor Baly and his collaborators, but nevertheless we still have much to learn from nature in regard to the synthesis of carbon compounds. This study of the products of the vital activities of animal and vegetable organisms was the original province of organic chemistry, and to this circumstance the science owes its distinctive name. During the last eighty years, however, organic chemists have extended the scope of enquiry to many substances which are produced not as the result of vital forces, but through the agency of the laboratory arts.

For instance, the organometallic compounds, which have no counterparts in nature, have received intensive study because of their influence on the development of modern chemical theory, their practical application in many operations of organic synthesis and their utilization as drugs, weapons of chemical warfare and antidetonants. No objection can be urged against the continued investigation of such important artificial products providing that naturally occurring organic materials are not overlooked.

Professor Japp's address supplies the philosophic reason for a closer study of the products of vital activity, and at present other more mundane considerations may be adduced in support of such researches.

Political and economic forces are bringing into prominence the urgency for a mutually advantageous interchange of commodities between the constituent nations and colonies of the British Empire, and in this pooling of natural resources organic chemistry must play an essential part. Many of the natural products of the dominions and dependencies are in need of systematic chemical study.

Animal and vegetable fats have been mentioned by an investigator in that field as constituting a neglected chapter of organic chemistry, but the phrase is at least as applicable to many other groups of organic substances, for example: the essential oils, the natural gums and resins, and the numerous products of fermentation processes.

By catalytic reductions, involving high temperatures and pressures, one obtains from the oxides of carbon many members of the homologous series of alcohols, aldehydes, fatty acids and esters. Plant life accomplishes similar results under ordinary atmospheric conditions. A comparative study of these two dissimilar sets of processes is clearly demanded.

The importance of imparting to organic chemistry an increasingly biological bias has been illustrated in a convincing manner by my immediate predecessor, Professor Barger, so that anything more than a passing reference to this desirable tendency is hardly required of me. Perhaps, however, I should add that in stressing the need of more systematic research in inorganic and mineral chemistry and in the organic chemistry of vital products, I am convinced that the best results will only be attained if the problems are attacked with the newest weapons which the armory of modern physics can provide.

The primary object of such investigations is the collection of accurate chemical information, but the workers in these two great fields should be stimulated in every possible way to keep a shrewd lookout for any practical applications of their scientific knowledge. When viewed from this standpoint it will be realized that a state experiment in chemical research such as I have described provides competent and enterprising investigators with favorable opportunities for developing their inventive talent in fundamental work of national value and importance.

OBITUARY

RECENT DEATHS

THE death is announced of Dr. W. Howard Forsyth, assistant professor of dairy husbandry at the Connecticut Agricultural College.

DR. EDWARD L. SPITZER, an attending physician and former president of the Jewish Memorial Hospital in New York, died on September 18 at the age of sixty years.

FREDERICK D. PRATT, engineer of the General Electric Company, who on March 8 sailed from New York with a group of other engineers to supervise the establishing of electrical plants for the Soviet Government in Russia, died on September 20 at Moscow.

CARL A. MEISSNER, metallurgical engineer, who has for twenty-five years been connected with the U. S. Steel Corporation, died on October 13, at the age of seventy-one years.

DR. LEWIS EVANS, collector of and writer on old scientific instruments, founder of the Lewis Evans Collection of Scientific Instruments in the Old Ashmolean Building at the University of Oxford, died on September 25, aged seventy-seven years.

HERBERT E. SOPER, statistician of the School of Hygiene and Tropical Medicine, London, died on September 10.

M. JEAN BRUNHES, who was for sixteen years pro-

fessor of geography at the University of Freiburg, Switzerland, died on August 25, aged sixty-one years.

A CORRESPONDENT writes: Dr. Carl Tigerstedt, professor of physiology of the University of Helsingfors, in an accident while sailing was drowned on June 21. Communications from his widow state that thus far his body has not been found. Professor Tigerstedt had visited America twice, the last time at the International Physiological Congress in August, 1929. The successor to his father, Professor Robert Tigerstedt, he had accomplished a great deal in research in physiology and particularly in nutritional studies in Finland. His loss will be keenly felt by all workers in nutrition.

GIULIO FANO, formerly professor of physiology and head of the faculty of science at the University of Florence and lecturer at the Universities of Madrid and Barcelona, died on September 28 at the age of seventy-four years.

PROFESSOR M. BOGOSLAVSKI, one of the bridge-building engineers of Russia, died at Leningrad on October 8 at the age of seventy-one years. He built the span over the Volga River. In recent years he had been a professor in the Institute of Communications at Leningrad.

DR. AKOS SZALAY, curator of the National Hungarian Museum, has been killed by a landslip while endeavoring to unearth a prehistoric canoe sunk under the embankment of the River Tisza.

MEMORIALS

AT the initiative of the Prime Minister of Norway, J. L. Mowinckel, twelve prominent Norwegians recently handed over to Professor Sem Saeland, rector of the University of Oslo, the sum of 100,000 crowns, about $25,000, for the purchase of "Polhögda," the home of Fridtjof Nansen at Lysaker, near Oslo, with the adjoining land, amounting to some 20,000 square meters. The donors desire that the property shall be kept as a lasting memorial to Nansen. They do not, however, wish his home to be turned into a museum, but rather to be utilized for the activities in which the explorer was interested, to be a residence and place where those activities can be carried on. The heirs of Nansen, who have already presented to the public his library and other possessions of public interest, have expressed their willingness to make over the estate for the purpose mentioned. Designs have been approved by the Soviet authorities for a monument to Fridtjof Nansen to be erected in Moscow.

Nature calls attention to the hundredth anniversary of the birth of Albert Günther, one of the most distinguished naturalists in England in the second half of the last century and for twenty years keeper of the Department of Zoology in the British Museum. To mark the centenary, his son, Dr. R. T. Günther, of Oxford, has prepared a bibliography of his father's writings, which has been published as a supplementary number of the *Annals and Magazine of Natural History* (August).

THE *Scottish Geographical Magazine* reports that in July last a massive stone cairn carrying a bronze tablet was unveiled at Inchnadamph, Sutherland, as a memorial to the two distinguished Scottish geologists, Benjamin Neeve Peach and John Horne. The tablet bears the following inscription: "To Ben. N. Peach and John Horne, who played the foremost part in unravelling the geological structure of the Northwest Highlands, 1883–1897. An International Tribute, erected 1930." Mr. H. M. Cadell presided at the unveiling ceremony, which was performed by Sir John Flett, director of the Geological Survey of Great Britain.

SCIENTIFIC EVENTS

THE BRITISH GEOLOGICAL MUSEUM

THE British Geological Survey Board reports that excavations preliminary to the construction of the foundations for the new building adjoining the Science Museum in South Kensington have begun.

In the "Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1929," as abstracted in the London *Times*, the director reports that the position in Exhibition Road is ideal for the purpose, being midway between the eastern wing of the Natural History Museum and the new buildings of the Science Museum. With both of these institutions the new Geological Museum is to have direct connection by means of passages through which the public can travel from one series of galleries to the other. In this way the mineralogical and paleontological galleries of the British Museum and the mining, metallurgical and geophysical galleries of the Science Museum will be in close juxtaposition with the exhibits of stratigraphical geology and economic geology in the Geological Museum, and the combined exhibition will provide a display of objects illustrating the composition and history of the earth's crust that has never hitherto been available in any country.

The work of construction will take at least three years. Although the details of the exterior of the building have not yet been finally settled, it is ex-

pected that the façade will resemble that of the Science Museum in its essential features. The library and offices of the Geological Survey are to be situated at the back of the new museum, with direct access from the exhibition floors and galleries. A large room is to be provided in the library for students, engineers and others who wish to consult geological maps and literature and as the library is in close contact with the science library, the public will find at South Kensington a vast accumulation of periodicals, memoirs and maps on all matters relating to geological science open for immediate reference. The new library will provide abundant space for books and maps, of which the survey has a magnificent collection, and the new offices and laboratories will greatly facilitate research and publication work by the staff.

The space occupied by the new museum is approximately 310 feet long by 105 feet in breadth. The museum in Jermyn-street, which at present does not provide accommodation for the whole of the survey staff, covers an area approximately 12,100 square feet, so that it is less than half as large as the new museum. The exhibition space contains three galleries similar in their general plan to those of the adjacent new wing of the Science Museum. Of these only two will be open to the public, the uppermost gallery being reserved for study and systematic collections to be consulted, especially by research workers. On the ground floor ample space is afforded for exhibits of general geological interest, and the galleries will be devoted to stratigraphy and economic geology.

The survey offices and library, at the back of the new building, occupy about one quarter of the cubic space provided. By this means adequate room will be obtained for the accumulations of geological material for many years, and the reference collections will be in well-lighted galleries accessible both to research workers and to the staff. Laboratory accommodation will be ensured for chemical, optical, petrographical, crystallographic, paleobotanical, geophysical and mineralogical work, which has been sorely needed for many years. It is expected also that certain rooms will be available for research workers who wish to investigate the maps and records or the collections of the survey.

The total floor space is about 135,000 square feet. Of this the survey offices with laboratories and library will occupy 40,000. The exhibition space on the main floor and the first and second galleries is 53,000 square feet. The basement provides 25,000 square feet, which will be used for storage, workshops and accommodation for subordinate staff. The uppermost gallery, reserved for study collections and research, has a floor space of over 16,000 square feet. Of the total floor space about two fifths will be allotted to exhibition of specimens, and of the remainder about one half will serve as offices, library and laboratories and one half as storage for collections.

THE GREAT SMOKY MOUNTAINS NATIONAL PARK

THE Attorney General has formally passed on the titles of the lands tendered the Department of the Interior by the governors of North Carolina and Tennessee which are to constitute the Great Smoky Mountains National Park. Following this action the land has been formally and finally accepted by the government.

National preservation of at least a portion of the most magnificent mountain scenery in the eastern section of the United States has thus been assured. The area covers 158,876 acres. These lands will form a nucleus for a great park with a minimum area of 427,000 acres. The park may be extended to include over 700,000 acres under the act of the Congress authorizing its establishment. Funds to acquire the minimum acreage are available to the States of North Carolina and Tennessee.

Already plans have been made for transferring from the western parks several men thoroughly trained in national-park work and policies, to undertake the protection and administration of the area now in the possession of the United States. This means primarily guarding the forests against fire and the plants, animals and natural formations against damage or destruction. Later, when the entire minimum area of 427,000 acres has been offered to the United States and accepted by the Secretary of the Interior, it will receive full park status. Then the Great Smoky Mountains National Park will be developed along the lines of those in the West. The necessary living and transportation accommodations will be provided, roads and trails constructed, and every opportunity afforded to enable visitors to get the fullest possible enjoyment and use out of the area, consistent with its preservation in its primitive condition for the use of future generations.

The area of the Great Smokies is a vast, unspoiled, primitive region, with spectacular mountains rising upwards 5,000 feet and more from their base. Particularly impressive are the luxuriant forests which clothe the peaks to their very summits. The park will be divided about equally between Tennessee and North Carolina, one great mountain range carrying the state boundary.

The new park will be a boon to the peoples of the highly developed industrial region of the east. It will be within reach of millions of people who, because of time and distance, are unable to take advantage of the

opportunities for enjoyment afforded by the western national parks.

The Great Smoky Mountains National Park is a ten-million-dollar project. When Congress authorized its establishment, it was with the proviso that all the lands to be included should be donated to the Federal Government. The states, realizing the importance of saving the area in its primitive condition and giving it national status, through their citizens and legislatures subscribed nearly $5,000,000 toward the desired end. This amount was matched by the Laura Spelman Rockefeller Memorial, in memory of Laura Spelman Rockefeller.

In addition to the Great Smoky Mountains National Park, two other large national park projects have been authorized by the Congress in the east, namely, the Shenandoah National Park in Virginia, and the Mammoth Cave National Park project in Kentucky. Funds for the acquisition of these areas are in the hands of the separate state agencies, and considered sufficient to acquire the land necessary for these parks. At the present time the only national park east of the Mississippi River is the Acadia in the State of Maine. Definite approval of the proposed Tropic Everglades National Park project in Florida also has been given by the Interior Department after an examination by its park experts established the fact that it measured up to high national-park standards.

THE SCOTT FUND EXPEDITION TO MONTANA

The first discovery of Dinosaur eggs on this continent, found this summer near Red Lodge in southern Montana by the Scott Fund Expedition of Princeton University, is reported by Dr. Glenn L. Jepsen, director of the expedition and instructor in geology at Princeton. A number of the broken remains of the eggs were found. The fragments resemble those found recently in Mongolia in several particulars, both occurring in closely similar geologic formations. The American remains were found in the Upper Lance formation, which was deposited in Upper Cretaceous time, while the Mongolian came from the Djadochta formation, which is also Cretaceous. Since the Mongolian formations are known to be older than the American it is logical to believe that the eggs found this summer are younger than those found in Mongolia.

The broken remains found by the Scott Fund Expedition are rough and pitted. These characteristics belong also to the Mongolian, although the American are black whereas those found in Mongolia are reddish brown. The original eggs were possibly larger than those found in Asia. Since no complete eggs were found this summer, Dr. Jepsen said it is the plan of the Scott Fund Expedition to return to the same locality at a future date to search for perfect specimens and to excavate for them if that is necessary.

While it is impossible to say what type of Dinosaur laid the eggs, they were found in close association with bones and teeth of the reptile genus Triceratops, which may be a descendant of the genus Protoceratops found in Mongolia.

Another find in close proximity to the egg fragments was the tooth of a new type of primitive mammal. The importance of this discovery, Dr. Jepsen explained, is that mammal remains found in formations of Cretaceous time are extremely rare. While the affinities and classification of the mammal tooth have not as yet been fully determined, Dr. Jepsen said that it may belong to the order Marsupialia and that although it is small it is larger than the few teeth which have previously been discovered in the Upper Lance formation.

The original problem on which the Scott Fund Expedition was working this summer was to discover the upper and lower boundaries in southern Montana of the Fort Union formation which lies on top of the Lance. In connection with the work of determining the upper boundary of the Fort Union formation, a large jaw was discovered which is believed to be a primitive species of Coryphodon, or one of its ancestors. The jaw is twelve inches long and has seven teeth, the front one being large and tusk-like. Early in the summer a large number of small jaws were found which will be added to the museum at Princeton and also used for research work. Some belonged to primitive primate-like animals about the size of a very small monkey. Others are what may prove to be the earliest ancestors of the Artiodactyls. This group includes the present-day cattle, hogs, sheep, antelope, camels and other well-known animals.

In addition to Dr. Jepsen, the party included Maurice Black, Commonwealth Fund Fellow of Trinity College, Cambridge, England; Kenneth Ridgeway, of Hempstead, L. I., and Edwin J. Moles, Jr., of Minneapolis, both seniors in the department of geology at Princeton University.

THE GEORGE FISHER BAKER NON-RESIDENT LECTURESHIP IN CHEMISTRY AT CORNELL UNIVERSITY

The George Fisher Baker non-resident lecturer at Cornell University for the present term is Dr. Georg Hevesy, professor of physical chemistry in the University of Freiburg, Germany. Professor Hevesy is a Hungarian by birth, having been born in Budapest in 1885. He first attended the University of Budapest, then the Technische Hochschule of Berlin

and later the University of Freiburg, where he received the degree of doctor of philosophy in 1908. After two years as assistant in the Technische Hochschule of Zurich, he carried on advanced research at Karlsruhe in Professor Haber's laboratory in 1910, and from 1911 to 1914 he held a research fellowship in the University of Manchester, working in the laboratory of Sir Ernest Rutherford. During this period he also carried on research work at the University of Liverpool in the laboratory of Professor Donnan.

He was then called to a position in the Radium Institute of Vienna, and in 1920 he became a member of Bohr's Institute of Theoretical Physics at Copenhagen. In 1926 he was called to the professorship of physical chemistry at the University of Freiburg. While connected with Bohr's institute he carried out, in cooperation with Dr. Coster, of Holland, a brilliant research that led to the discovery of the new element hafnium.

A correspondent writes: "The many and diverse investigations of Professor Hevesy have lain in the fields of inorganic chemistry, physical chemistry, electrochemistry, radioactivity and the separation of isotopes, and his researches are characterized by brilliancy of conception, unique experimental attack and convincing thoroughness."

During the coming term Professor Hevesy will lecture on five different topics, as follows: "Chemical Analysis by X-rays and its Applications," "Rare Earth Elements and Atomic Structure," "Chemistry of Hafnium," "Electrolytical Conduction and Diffusion in Solids," "Separation of Isotopes."

SCIENTIFIC NOTES AND NEWS

Jewish residents of Montevideo have taken up a popular subscription to present a statue of Professor Albert Einstein to the city on the occasion of Uruguay's centenary of independence. The statue will be erected in one of the most prominent plazas of the city.

Sir Arthur Stanley Eddington on September 25 received the honorary freedom of the town of Kendal, Westmoreland, England, his birthplace. In handing him a scroll recording the decision of the Town Council, the Mayor said: "Kendal is determined it will not leave the recognition of its most distinguished sons to a future generation." It was pointed out in an appreciation sent by Sir Oliver Lodge that it was in Kendal that John Dalton, as first assistant master of a school, began his scientific work.

Abbé Henri Brouil, professor in the Institut de Paleontologie Humaine, Paris; Sir Arthur Keith, of the Royal College of Surgeons, London, and Professor Grafton Elliot Smith, of University College, London, have been elected corresponding members of the Field Museum of Natural History in recognition of services rendered to the museum.

Dr. T. Wayland Vaughan, director of the Scripps Institution of Oceanography of the University of California, was at the meeting in Eugene, Oregon, elected president of the Pacific Division of the American Association for the Advancement of Science for the year 1930–31.

Mr. Charles G. Dawes, ambassador to England, has accepted appointment as the delegate of the National Geographic Society to the one hundredth anniversary celebration of the Royal Geographical Society, London, on October 21. Mr. Dawes is a member of the board of trustees of the National Geographic Society.

Professor Francis G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution of Washington, was the guest of honor on October 3 at a dinner given for him by friends and associates at the Algonquin Club, Boston, to celebrate his sixtieth birthday. Professor George H. Parker presided, and the speakers were Dr. Elliott P. Joslin, Dr. Eugene F. DuBois, Dr. George W. Crile, Dr. Allan Winter Rowe and Professor Benedict.

Dr. Otto Oldenberg, professor of physics in the University of Göttingen, has accepted a call to Harvard University. Professor Oldenberg lectured at Harvard University last year.

Professor Edgar T. Wherry has resigned from the position of principal chemist in charge of the crop chemistry laboratory, Bureau of Chemistry and Soils, to become associate professor of plant ecology in the department of botany of the University of Pennsylvania.

Dr. Alexander Goetz, of the University of Göttingen, has been called to an associate professorship of electrophysics in the California Institute of Technology.

At a recent meeting of the agricultural council of the Board of Trustees of Cornell University, Dr. D. C. Carpenter was named head of the division of chemistry of the State Agricultural Experiment Station at Geneva, New York. Dr. Carpenter has been engaged for the past several years in researches on casein both at Geneva and at the University of Upsala, Sweden. At the same time the council promoted Leon R. Streeter from associate in research to be chief in research, and Dr. Z. I. Kertesz from assistant in research to associate in research in chemistry. The appointment of Dr. J. J. Kercura, formerly of the

Ohio State University, to be an assistant in research in chemistry on the station staff is also announced.

It is reported by the Department of Commerce in Washington that Mr. E. B. Swanson has been appointed chief economist of the division of petroleum economics of the United States Bureau of Mines. Mr. Swanson has been serving as acting chief of the division since October, 1928. Other recent personnel changes in the petroleum economics division included the promotion of G. R. Hopkins from associate petroleum economist to economic analyst and of A. H. Redfield from assistant scientist to associate economic analyst.

Dr. Addams S. McAllister has been appointed assistant director in charge of commercial standardization in the Bureau of Standards. The appointment of Dr. McAllister fills a vacancy created by the resignation of Mr. R. M. Hudson on December 31 of last year.

Mr. H. W. Dickinson, senior keeper in the Science Museum, South Kensington, England, retired on September 1.

Professor G. E. MacGinitie has been appointed acting director of the Hopkins Marine Station of Stanford University for the autumn quarter during the absence of Dr. W. K. Fisher.

Major James Stevens Simmons, who for the past two years has been president of the Army Medical Department Research Board at the Bureau of Science, Manila, has been assigned to the staff of the Army Medical School, Washington, as instructor in charge of the bacteriological department.

Dr. Ferdinand W. Haasis recently resigned his position as associate professor of forestry at the University of Idaho to become research associate of the Carnegie Institution of Washington. He is working with Dr. D. T. MacDougal at the Coastal Laboratory of the Division of Plant Biology, Carmel, California.

Professor R. B. Thomson, professor of anatomy and head of the Department of Botany of the University of Toronto, has been granted leave of absence for the collegiate year 1930–31, because of ill health. Dr. H. S. Jackson, professor of mycology, has been appointed acting head of the department during Professor Thomson's absence.

Dr. Oscar Riddle, of the Carnegie Institution, Cold Spring Harbor, returned to New York on October 2 from a visit to various laboratories in Europe. He served as chairman of the American delegation at the International Congress for Sex Research, London, and as a vice-president at the International Congress of Zoologists, Padua.

The Tulane University medical expedition to Central America to study the relationship of tropical diseases to men and monkeys, under the direction of Dr. E. C. Faust, has returned from visiting the jungles of the Canal Zone.

A detailed survey of the city of Rio de Janeiro and environs with a study of inland waters is to be undertaken by Dr. Preston James, professor of geography at the University of Michigan.

Dr. Hugh M. Smith, who has been in Siam for several years establishing a department of fisheries for the Siamese government, is on a vacation in the United States for several months. While in Siam he has been making a collection of birds and other natural history objects in his spare time and has already presented several thousand birds to the National Museum, with another large shipment on the way, chiefly from the mountains of northern Siam and localities on the eastern border of that country, where little natural history work has been carried on.

The department of chemistry of the Pennsylvania State College, in cooperation with the department of electrical engineering, announces that the fifth annual Priestley Lectures will be given by Dr. John W. Williams, assistant professor of chemistry of the University of Wisconsin, on November 10, 11, 12, 13 and 14, at 7 P. M. The general subject of the lectures will be "The Relation between Physical Chemistry and Electrical Engineering."

The twenty-third Hanna Lecture was delivered at the School of Medicine, Western Reserve University, on September 25 by Professor Franz Knoop, professor of physiological chemistry at the University of Tübingen, on "The Significance of the Intermediary Metabolism." On September 26 he gave a second lecture in which he presented an informal review of his work on beta-oxidation.

The Harben Lectures for 1930 were delivered on October 6, 7 and 8 at the Royal Institute of Public Health, London, by Professor William H. Park, director of the Bureau of Laboratories, Health Department, New York City.

The British Science Guild announces that the sixth annual Norman Lockyer Lecture will be delivered by Professor Sir William Pope, on November 13.

The Harveian Oration will be delivered before the Royal College of Physicians of London on October 18 by Professor John Beresford Leathes, F.R.S.

The American Astronomical Society will hold its forty-fifth meeting in New Haven. The date of the meeting has not been set definitely but it will probably be the latter part of the week December 28 to January 3.

THE Ninth Annual Exposition of Power and Mechanical Engineering is to be held from December 1 to 6 in the Grand Central Palace, New York, N. Y., under the leadership of I. E. Moultrop, chairman of the advisory committee of the exposition. This year plans call for an exhibit which will include many indications of progress during the year which has already seen numerous mechanical advances.

THE Seventeenth French Congress of Hygiene will be held at the Institut Pasteur, Paris, under the presidency of Professor Delépine, of the Académie de Médecine, from October 20 to 23, it is announced in the *British Medical Journal.* The following subjects will be discussed: the successive changes in the French pharmacopoeias, introduced by the president; comparative statistics of infantile mortality, introduced by Dr. Lesage; the relation of health offices to health inspection, introduced by MM. Aublant and Prunet, and Brocquin-Lacombe and Bennet; and hygiene and reconstruction in the flooded area in the south of France. Lectures will also be delivered by Professor Sacquépée on psittacosis, and by Dr. Dujarric de la Rivière on Lavoisier as hygienist. Further information can be obtained from Dr. Dujarric de la Rivière, Institut Pasteur, Rue Dutot, Paris, XV^e.

MR. EDWARD S. HARKNESS has given to Columbia University $500,000 to supplement his original gift of $2,000,000 for a residence hall at the Medical Center.

AN exposition, the object of which will be to demonstrate the general health conditions and progress in physical culture in Switzerland, will be held in Berne next year. The exposition will be divided into groups, as follows: Climatic; climatic and bathing resorts: housing; architecture, popular dwellings, unhealthy houses and quarters, heating systems, cleaning, ventilation, disposal of refuse, drinkable water: food; meat and its food value, unhealthy meat, animal diseases, milk and milk products, frauds and unsanitary handling of food products, sanitary maintenance of stables, vegetables' nutritive value, falsifications: fashions and clothing; history of clothing, methods of examining tissues and colors, irrational and eccentric clothing, industry and trade. Corporal hygiene and sports; physiological effects of hygiene, bathing and baths, sport societies and establishments: labor; protection of workers, safeguards and insurance: infectious diseases; campaigns against epidemics, vermin and parasites: care of sick and ailing; hospitals, clinics, polyclinics, dispensaries, training schools for nurses, National Red Cross. Scientific and medical research; goiter, cancer, intoxication, alcoholism, origin, preparation and use of medicines: child welfare; traffic; sanitary installations, traffic rules, antidust campaign: man; anatomy and physiology, medical and natural science history, racial hygiene and heredity. Statistics; statistics pertaining to hygienic and medical facts: sanitary service of the army: industries and trade; general review of present sanitary and hygienic conditions and facilities.

DISCUSSION

YARDANG AND ZASTRUGA

USING the right term in the right place is like choosing the proper tool for a particular operation in carpentry. Both facilitate good work. Hence this note regarding two terms useful to geologists but somewhat confused in usage and not yet widely employed.

The words *yardang* and *zastruga* denote certain features made by the action of the wind. The first is a native Asiatic word utilized by the explorer Sven Hedin[1] to name the curved and often undercut ridges that the sandblast carves from weakly indurated deposits of silt and sand. Such forms are found in all deserts. The German spelling used by Hedin is "jardang" but the Anglicized form is preferable for English-speaking workers.

Zastrugi (singular *zastruga*) are wind-made ridges of snow, well known to polar explorers and to dwellers in cold regions in general. The Russian word *zastruga* means a splinter made by planing a board against the grain.[2] From that it was modified to designate a sand bank undercut by a stream and also mere sand bars built by currents. In Siberia it came to be used for the low ridges, most of them sharply undercut on the windward side, that are characteristic of snow surfaces abraded by strong winds. The first use of the term in scientific writings, so far as the writer has been able to learn, was in a geographical report by Baron von Wrangel[3] who thus referred to the wavy ridges on the snow in the Arctic wilderness. In transliterating into German, the Russian *zastruga* became *sastruga,* and the latter spelling has unfortunately been adopted by most later English and American writers. The Century Dictionary, however, gives only the original and correct form, *zastruga.*

Snow, sand and silt are all mineral deposits of sim-

[1] Sven Hedin, "Central Asia and Tibet; towards the Holy City of Lassa," Vol. I, p. 365, 1903.

[2] Vladimir Dal, "Explanatory Dictionary of the Russian Language," Vol. I, p. 661, 1880.

[3] Baron Ferdinand P. v. Wrangel, "Journey along the North Coast of Siberia," pp. 311–312, 1839.

ilar grain and consistency. The action of the wind upon them forms almost identical features, some by erosion and others by heaping up the material swept from elsewhere. In view of these facts it seems at first glance that one term for the eroded ridges and another for the built features would suffice. We might then have silt zastrugi and snow zastrugi and also sand dunes and snow dunes. Out of 28 geologists and explorers to whom I have referred the question seven adopted this position, while two made no choice.

Of the fourteen who believe that both *zastruga* (or less correctly *sastruga*) and *yardang* are needed terms and should be retained, some are influenced by the fact that snow differs from silt in being subject to melting. Others, including three Arctic explorers and two eminent geomorphologists, employ the word zastrugi to denote the various minor irregularities of the snow surface whether due to erosion, deposition or differential melting.

The yardang is apparently a definite type of land form due exclusively to the abrasive action of wind on suitable material. If any one chooses to speak of *snow yardangs* he will be perfectly understood, as he will be also in speaking of *snow dunes, snowslides* and *snow ripples*. The term zastrugi, however, has never been thus limited, and it is evidently in common use by Arctic explorers to describe features some of which are wind carved, others wind built and some not wind made at all. From these facts it may be concluded that both terms probably have their uses and will be retained, but of the two yardang is the more definitely limited in meaning and hence more satisfactory for the purposes of the careful geomorphologist. Zastruga is likely to be used chiefly by Arctic explorers and geographers not primarily concerned with processes of land sculpture.

ELIOT BLACKWELDER
STANFORD UNIVERSITY

WHAT IS CHITINE?

THE entomologists and the chemists have come to a curious dilemma with reference to this very common word. The entomologists universally give it a physical interpretation, using it to refer to the characteristic system of organic substances which make up the insect exoskeleton, while the chemists as consistently use it of a single chemical compound, which they can isolate by the proper chemical processes from this complex. Many people have assumed that the difference was trivial, on the ground that the chemists' "chitin" was the principal substance of the entomologists' "chitin." In fact, Campbell's recent study[1] shows plainly that the chemists' chitin is in fact a secondary constituent of the insect skeleton, never constituting more than half of its substance, and occasionally (as in egg-shells and tracheal lining) wholly wanting.

On turning to the original proposal of the term,[2] we find that the author undoubtedly was the originator of the misconception that his chitine was the principal substance, on account of the somewhat loose way in which he presents his analysis; but that he obviously had specially in mind the substance that the chemists now call chitin (or rather chitosan), and that he postponed for a later study, which I believe never was carried out, the study of the larger amount of substance which he calls "the part of the precipitate insoluble in alcohol" on page 33, and which obviously includes the substance or substances which give the insect exoskeleton its hardness, its color and the major half of its substance.

Shall entomologists then continue to call "chitine" the substances that make the exoskeleton of insects, as they have been doing for nearly a century, since Newport, or shall they grant to the chemists a word which was originally proposed by a chemist and has had an even longer period of use in chemistry, though there is an older name (fungine) for the same substance? I suspect that we shall probably go on as we have been doing; the entomologists will use chitine (like bone) for a physical system of substances which is formed into structures of interest to them; while the chemists will continue to use it of the soft transparent "filler" of the insect skeleton which is on the whole of very little interest to the entomologist, but is a chemical substance of known composition.

There seems need for further research on both sides; the composition of the substances which give the insect skeleton its hardness and its characteristic tint has never been made out—a thing which only the chemists can do; and there is need for the entomologist in turn to find what place in the insect economy is taken by this other substance the chemist calls chitin, and which so commonly makes up a substantial proportion of the skeleton.

WM. T. M. FORBES
CORNELL UNIVERSITY

TOPOGRAPHIC CONTROL OF CLOUD DISTRIBUTION

IN Giles and Montgomery Counties, Virginia, and the adjacent portion of West Virginia, there are three minor physiographic provinces, the state line separating the northwestern from the central. The Cumberland plateau, the northwestern province, is made up of round and oblong hills which rise to

[1] *Annals Ent. Soc. Am.*, 22: 401–426, 1929.

[2] Odier, *Mém. Soc. Hist. Nat. Paris*, 1: 29–43, 1823.

heights of 1,000 feet above drainage. The Central or Alleghany province is composed of linear ridges separated by valleys of varying width, trending northeast-southwest, with seven more or less definite parallel ridges in a distance of 14 miles rising to heights of 1,000 to 2,000 feet above drainage. The southeastern, or Great Valley province, is a broad valley consisting of a dissected peneplain which lies at an elevation of about 2,100 feet.

It sometimes happens in this region that the alignment of clouds with mountain ridges is so conspicuous that there can be little question but that the distribution of clouds is determined by the topography. This is likely to be conspicuous when there are continuous thin clouds covering the Cumberland plateau and moving to the southeastward. As the cloud mass moves over the Alleghany province there is a gradual alignment of clouds in the northeast-southwest direction paralleling the mountain ridges, separated by narrow cloudless areas, and the perfection of this arrangement increases with progress southeastward across the ridges. This parallelism is maintained for several miles over the Great Valley and gradually becomes less definite.

R. J. HOLDEN

TWIN SEEDLINGS IN ANGIOSPERMS

IN SCIENCE for May 16, 1930, one of the items of the Supplement page xiv has to do with the possibility of two plants being produced from a single seed. "Mrs. Tema Shults Clare, a teaching fellow at the University of Southern California, has obtained in two instances pairs of twin seedlings sprouting from Torrey pine seeds, and one pair of similar twins from the seed of a piñon pine." To this report is added the following statement: "This habit of twinning from single seeds is peculiar to the gymnosperms. The higher seed plants, the producers of showy flowers, apparently do not have this possibility."

In SCIENCE for August 23, 1929, R. H. Woodworth reported the production of two embryos from one seed of *Alnus rugosa*, a species of the Betulaceae which is a family of the Angiospermae. From a sowing of 150 seeds about 50 per cent. germinated and six of these produced twin seedlings. The pairs have developed quite normally into young plants. This phenomenon is considered at length in a paper entitled "Parthenogenesis and Polyembryony in *Alnus rugosa*," which appeared in the *Botanical Gazette* for June, 1930.

It is also well known that the citrus fruits, particularly the grapefruit, produce seeds which frequently give rise to more than one seedling.

ROBERT H. WOODWORTH

BOTANIC GARDEN,
HARVARD UNIVERSITY

MINERAL RESOURCES OF GREECE

ONE usually thinks of Greece as the home of decaying monuments to immortal thinkers and writers. Few of us realize that Greece is a wealthy country. The ancient Greeks did considerable mining of copper, silver and tin, but they did not begin to touch the wealth of other minerals which lay beneath the soil. The development of natural resources has remained inactive for ages.

The Germans were pioneers in extracting some of Greece's mineral wealth and are still active in some localities. The British have long been quarrying the valuable and extensive marble deposits, but on the whole a vast and virgin area remains to be worked.

The more abundant ores found in Greece are those of iron, lead, sulfur and magnesium. The yearly production of these ores averages 322,000 tons. Iron ore mined amounts to 88,000 tons containing 42–62 per cent. iron. Lead is mined to the extent of 76,000 tons. This ore is rich in silver. Magnesite occurs throughout Macedonia and contains 95 per cent. magnesium carbonate. Other ores extracted in lesser amounts are those of zinc, nickel, chromium, manganese, aluminum, copper and antimony. The total amount mined approaches 30,000 tons yearly.

MAURICE H. BIGELOW

UNIVERSITY OF PITTSBURGH

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PRACTICAL METHOD OF DETERMINING THE FALL IN POTENTIAL IN A MICRO-ELECTROPHORESIS CELL[1]

A PRACTICAL method of determining the fall in potential in a micro-electrophoresis cell is described, whereby it is possible to determine the fall in potential at any stage of an experiment without any loss of time.

The method is a so-called null method and in principle consists of balancing two unknown circuits using a precision voltmeter to register the voltage in one circuit necessary to balance the other, as indicated by a sensitive galvanometer. A certain definite assembly of apparatus was found to be most satisfactory. Fig. 1 indicates the apparatus used together with the connections, and is self-explanatory. The Central Scientific (Weston) galvanometer is placed in the circuit for preliminary balancing.

[1] From the Laboratory of Hygiene, Department of Pensions and National Health, Ottawa, Canada.

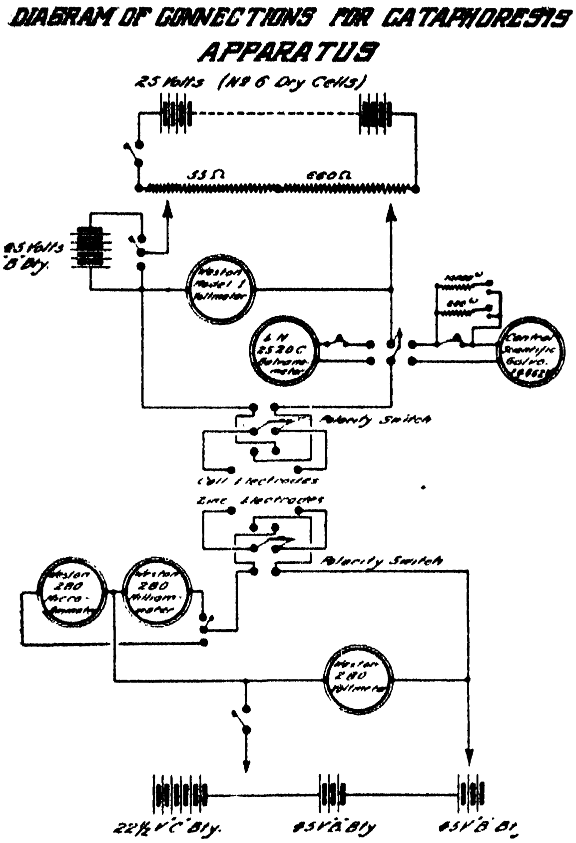


FIG. 1

Polarization may take place if any appreciable current is drawn from the cell electrodes. It is therefore advisable when balancing a circuit not to depress the key switches longer than is necessary to cause deflection of the galvanometer. After a little experience this difficulty is never encountered.

The method and apparatus herein described have been used for several months with a Northrup-Kunitz design of cataphoresis apparatus, and has proved to be of distinct value in controlling experimental work.

The author wishes to express his appreciation of the advice and assistance given by Captain R. A. H. Galbraith, of the Royal Canadian Corps of Signals.

JAS. GIBBARD

THE MEASUREMENT OF ARM GIRTH

FRANZEN has emphasized arm girth and calf girth in measures of growth and nutrition.[1] The instrument in common use for obtaining these measures is a tape wound about a coiled spring in a small metal case. To keep the tension more or less constant in measurements, a handle is provided with a spring to balance the spring of the case.

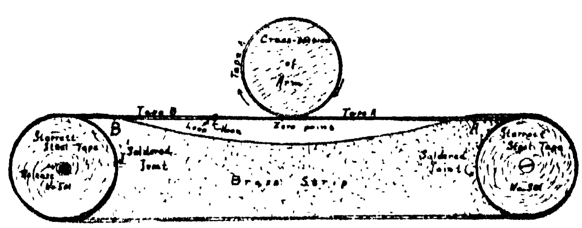


FIG. 1

The figure printed herewith is a drawing to illustrate a method of mounting two steel tapes so that the tension of one may be balanced by that of the other.[2] When one tape has been looped around the member to be measured, it is attached to the end of the other and both springs are released by the pressure of the thumb of one hand and a finger of the other. Tension is thus controlled automatically. The instrument, which may be called a girthometer, is entirely practicable, having been used for measuring thousands of arm girths under the direction of the writer.

H. T. MANUEL

UNIVERSITY OF TEXAS

[1] R. Franzen, "Physical Measures of Growth and Nutrition," American Child Health Association, 1929.

[2] The writer was assisted in making the first of these instruments by Mr. Wm. Sachs. While no complete check of the literature has been made, nothing like it has been found in the references consulted. The instrument was devised for use in a study financed by the University of Texas Fund for Research in the Social Sciences.

SPECIAL ARTICLES

THE LOGISTIC CURVE AND THE CENSUS COUNT OF 1930[1]

EARLY in 1920 we published[2] the results of fitting a logistic curve to the census counts of the population of the United States from 1790 to 1910, inclusive. At the time the computations were made in 1919 the results of the census of 1920 were not available, and therefore were not and could not be included in the calculations. Soon after the original paper was published the notation was improved, and the curve took the definitive form, still, however, *without* the use of the 1920 count,

$$y = \frac{197.27}{1 + 67.32e^{-0.0313x}} \qquad \text{(i)}$$

[1] From the Department of Biology and the Department of Biostatistics (Paper No. 153), of the School of Hygiene and Public Health of the Johns Hopkins University.

[2] Pearl, R., and L. J. Reed, "On the Rate of Growth of the Population of the United States since 1790 and Its Mathematical Representation," Proc. Nat. Acad. Sci., Vol. 6, pp. 275–288, 1920.

where y denotes calculated population in millions, and x time, in base units of one year.

A basic implication of the logistic theory of population growth is that such growth proceeds in an orderly manner according to some law, to which the logistic curve may be taken as a first approximation, so long as the conditions under which the population is growing are not seriously or suddenly altered. Without any thought of implying the possession of any knowledge as to whether, or when, or by how much, the conditions under which the population of the United States had grown between 1790 and 1910 might change subsequent to 1910, we did, as a matter of interest, in our original publication discuss the extrapolation to the year 2100 of the equation given above. At that date this particular curve will be very close to its asymptote of 197.27 million. This logistic curve has not lacked attention in many places and from various persons. It has, in fact, been much discussed, sometimes with approval and sometimes with disapproval. Throughout the mild tempest which has raged about the logistic theory of population growth during the past decade the authors of this paper have refrained from altering the logistic equation for the United States from its original form reprinted above, having seen no reason to do so, and being content to await the passage of time and the course of events to furnish an impartial judgment regarding its validity and usefulness.

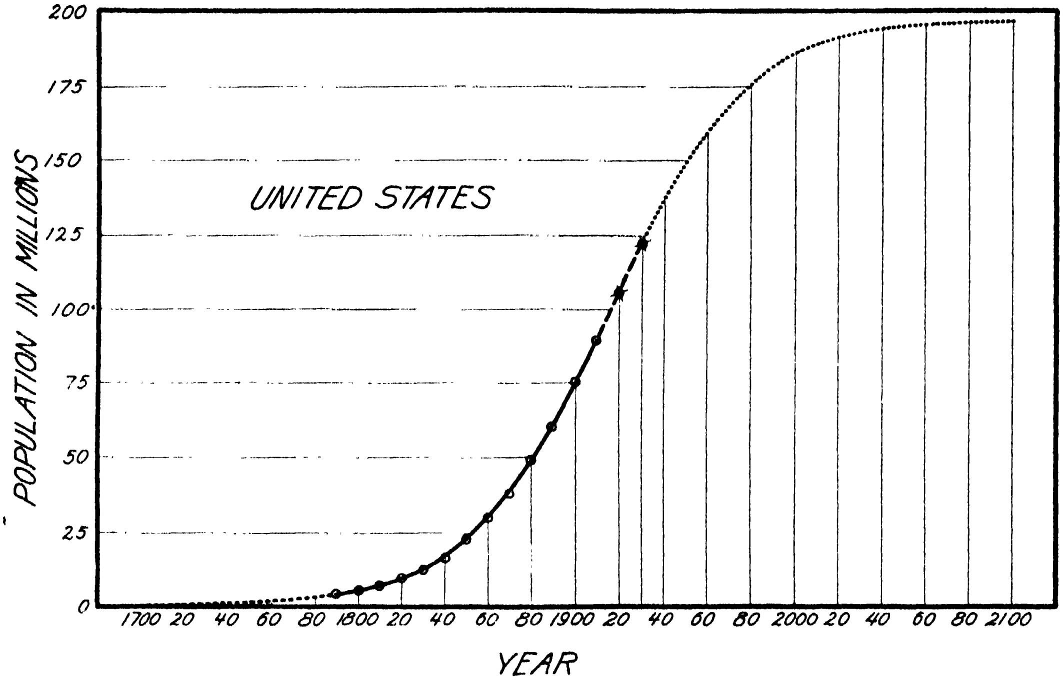


FIG. 1. The census counts of the population of the United States from 1790 to 1930, inclusive (given by circles). The smooth curve is the logistic of equation (i) above fitted to the census counts from 1790 to 1910 inclusive. The broken lines show the extrapolation of the curve beyond the data to which it was fitted. The dash portion from 1910 to 1930 is the part of the extrapolation which has been tested by census counts (crossed circles) which have been made since the logistic was originally fitted. The dotted line shows the further extrapolation of the same curve.

Twenty years have elapsed since the last *datum* (the census count of 1910) available when the curve was calculated. It seems justifiable now to make some examination of how the case goes. The following little tabulation, and Fig. 1, give the facts.

Population of Continental United States
(in millions)

	A. As forecast by logistic equation (i) (data of 1790–1910)	B. As counted by the Census Bureau
1920	107.4	105.7
1930	122.4	122.7

It thus appears that the forecast of the logistic curve (equation (i)) missed the counted population by *16 parts in a thousand* in excess in 1920, and by *2.5 parts in a thousand* in defect in 1930.

In conclusion, we wish again to emphasize, as we have repeatedly in the past, that it is a basic postulate of the logistic theory of population growth that any particular population can be expected to continue

to follow in its later growth the same logistic curve which it has followed in its earlier growth *only* if there has been no serious or cataclysmic alteration of the conditions (climatic, geological, biological, economic or social) under which its earlier growth has taken place. The present evidence indicates that the population of the United States during the period 1910–1930 continued in its growth along the same logistic curve that it had followed in the period 1790–1910.

RAYMOND PEARL
LOWELL J. REED

LIGNIN AS A POSSIBLE FACTOR IN LODGING OF CEREALS

LODGING is the laying over of the cereal plants at a period when their vegetative growth is nearly completed. It interferes with the normal development of the grain, frequently causing a loss of from five to ten bushels per acre.[1] The accepted opinion is that lodging is generally caused by nitrogenous overnutrition, as it occurs most frequently on naturally fertile soils rich in humus and on soils heavily fertilized with manure or inorganic nitrogen carriers. Lodging is consequently more of a problem under conditions of intensive cultivation than under those of extensive cultivation.

The immediate causes of lodging have been a matter of controversy for more than a century. Sir Humphry Davy[2] in 1798 associated lodging with a low silica content of the straw, although, as was characteristic of his time, his views were based largely on speculation. In 1842 Liebig,[3] the "father of agricultural chemistry," also attributed lodging to a deficiency in silica. His views were supported by a number of investigators but were opposed by the pioneer plant physiologist Sachs[4] and others. In 1900 Swiecicki,[5] after a thorough analysis of the opposing views of Liebig and Sachs and their respective followers and on the basis of his own experiments, upheld the view that lodging is caused by a deficiency in the silica content of the straw. He found that the silica content was invariably lower in lodged oats and barley than in normal crops of these cereals grown under comparable conditions. More recently Headden[6] and Davidson and LeClerc[7] found that the application of sodium nitrate, which frequently causes lodging, depressed appreciably the ash and silica content of wheat straw. In view of all this evidence pointing toward silica deficiency as a possible factor in lodging, it is remarkable that Welton,[1] who recently made an extensive investigation of the causes of lodging, did not deem it necessary to include ash and silica in the analytical examination of his materials.

Another factor which is considered as one of the causes of lodging is a deficiency in the lignin content of the plants.[1,4] It has been assumed that lignin lends mechanical support to the stalks, thus preventing them from falling over. The Bureau of Chemistry and Soils has undertaken to ascertain whether or not lignin is a factor involved in lodging of cereals.

Two wheat plots, about 1/50 acre each, were selected in the same field on the Arlington Experimental Farm. One received no fertilizer treatment and served as a control; the other received early in spring sodium nitrate at the rate of 600 pounds per acre, obviously a high application for wheat. The wheat on the fertilized plot grew luxuriantly but suffered from characteristic lodging close to the "milk" stage of the grain. That on the control plot remained erect until harvested. Samples cut from the two plots at frequent intervals up to maturity were analyzed for total ash, silica and other ash constituents, and lignin.

The results, which will be published in full elsewhere, corroborate those of Swiecicki and of Davidson and LeClerc mentioned above. The silica and ash content in the straw from the fertilized-lodged plot was in every case lower than from the control plot.

What came as a surprise, however, was that, contrary to the views of Sachs and of Welton, the lignin content of the straw from the fertilized-lodged plot was distinctly higher in every case than of that from the control plot. Accordingly, should the cause of lodging be sought in lignin-content variations between the lodged and erect plants, the conclusion would have to be reached that a high and not a low lignin content is the cause of lodging. This is in accord with the recent work of Dadswell and Hawley,[8] who found that brash specimens of Douglas fir contained a higher lignin content than tough specimens. It

[1] F. A. Welton, "Lodging in Oats and Wheat," *Bot. Gaz.*, 85: 121, 1928.

[2] Davy, "Elements of Agr. Chemistry," p. 51, 1813.

[3] Liebig, "Die Chemie in ihrer Anwendung auf Agriculturchemie und Physiologie," 1 Theil, "Ernährung der Vegetabilien," p. 168, 1862.

[4] Sachs, "Experimental-Physiologie der Pflanzen," p. 150, 1865.

[5] Vitold von Swiecicki, "Die Anwendung der Kieselsäure als Bestandteil der Pflanzen und ihre Beziehung zum Lagern des Getreides," Berichte aus dem Physiologischen Laboratorium und Versuchanstalt des Landwirtschaftlichen Instituts der Universität Halle, p. 66, 1900.

[6] W. P. Headden, "A Study of Colorado Wheat," Part III, Colo. Exp. Sta. Bul. 219.

[7] Jehiel Davidson and J. A. LeClerc, "Effect of Various Inorganic Nitrogen Compounds Applied at Different Stages of Growth on the Yield Composition and Quality of Wheat," *Jour. Agr. Res.*, 23: 55, 1923.

[8] H. E. Dadswell and L. F. Hawley, "Chemical Composition of Wood in Relation to Physical Characteristics. A Preliminary Study," *Ind. Eng. Chem.*, 21: 973, 1929.

would seem that the relatively higher lignin content makes the straw (or wood) brittle so that it tends to break under the violent impact of winds, whereas with a normal lignin content the plants only bend and straighten out again.

No explanation can be offered at present for the increase in lignin caused by nitrogenous hypernutrition. It may be due to an effort on the part of the plant to overcome the weakening of the culms caused by the relative decrease in silica.

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THE NATIONAL ACADEMY OF SCIENCES. II

Salts of the enolic form of quinaldine: F. W. BERGSTROM (introduced by E. C. Franklin). Formally quinaldine is a ketone of the ammonia system because of the CH_3–C = N– grouping, but the ketonic properties are generally subordinated to the stability of the six-membered ring. Nevertheless quinaldine reacts readily with liquid ammonia solutions of the ammono bases, KNH_2, $NaNH_2$, $LiNH_2$ and $Ba(NH_2)_2$ to form salts. These salts are colored a deep red and are very reactive. A liquid ammonia solution of ammonium bromide reacts with them to form an unstable ammonium salt, or perhaps the pseudo quinaldine itself, which soon changes into ordinary quinaldine. Methyl iodide and ethyl bromide, in liquid ammonia solution, react to form, respectively, 2-ethyl and 2-n-propyl quinoline, a reaction akin to the alkylation of acetoacetic ester. The potassium salt of the enol modification of quinaldine is readily soluble in ether. The above-mentioned reactions can also be carried out in ether solution.

The rotation of the planets Uranus and Neptune determined from spectroscopic observations (illustrated): J. H. MOORE (introduced by R. G. Aitken). In 1911 Lowell and Slipher found from their spectrographic observations of Uranus that the planet is rotating in the same direction as that of the revolution of its satellites and with a period of 10¾ hours. Leon Campbell, Slavenas and others have reported a variation in the planet's light in very closely this period, while Stebbins, from observations made with the photoelectric photometer, concluded that the light of Uranus is constant. Recent observations obtained at the Lick Observatory with spectrographs of three-prism and one-prism dispersion confirm the direction of the planet's rotation as found by the Lowell observers. The period of rotation derived from fifteen one-prism spectrograms in 1928, 1929 and 1930 is of the order of that previously found. The three-prism spectrograms to which exposures of 6 hours were given are under exposed and difficult to measure. The period derived from two of these obtained in 1927 is 11.5 hours. A consideration of the probable sources of the discrepancy in observations of planetary rotation obtained with different spectrographs shows that for objects like Uranus and Neptune with small apparent disks the rotation period determined spectrographically is at best only approximate. Seven well-exposed spectrograms of Neptune were obtained with the one-prism spectrograph in 1928. The slit was placed parallel to the planet's equator, the position of which was derived by Eichelberger and Newton on the assumption that the well-known motion of the plane of the satellite's orbit is caused by the attraction of an equatorial protuberance on the planet. All these spectrograms show a very noticeable inclination of the spectrum lines, in the sense that the portion of the line originating at the east limb of the planet is displaced toward the violet, indicating that the rotation of Neptune, like the other planets, with the exception of Uranus, is direct. The measured inclination of the lines yields an approximate period of rotation for Neptune of 15.8 ± 1.0 hours. The investigation of the rotation of Uranus and Neptune was carried on jointly by the author and Dr. D. H. Menzel.

Spectrophotometric measures of interstellar light-absorption (illustrated): ROBERT J. TRUMPLER (introduced by R. G. Aitken). The investigation of open star clusters recently furnished some definite evidence that within our Milky Way system light rays, passing through interstellar space, suffer a loss of intensity. Such a phenomenon is usually designated as "absorption" in the most general sense of the word. On the one hand the evidence is based on the fact that distances of open star clusters derived from their angular diameters do not agree with those derived from magnitudes and spectral types of the stars. On the other hand, we also find a change of color with distance for stars of the same spectral type, which indicates that the absorption is selective, *i.e.*, that it depends on the wave-length of the light. In order to gain information on the physical process causing this absorption and on the nature of the absorbing medium, it is of prime importance to find the law according to which the absorption depends on the wave-length. For this purpose the spectra of the brighter stars in the clusters N.G.C. 6910 and N.G.C. 6913 (distance about 2,000 parsecs) were observed with the slitless quartz spectrograph of the Crossley Reflector and compared with the spectra of relatively near stars of the same spectral type. Taken on Panchromatic plates these spectra cover the region from 6300 A to 3200 A and show at once the great difference in the intensity distribution of the continuous spectrum between near and distant stars. This difference, which must be an effect of interstellar light absorption, was measured with a Moll self-registering microphotometer. The results show that the absorption increases rapidly with decreasing wave-length; but the absorption does not seem to be inversely proportional to the fourth power of the wave-length, which law should hold if the effect were due to Rayleigh scattering by extremely small particles.

Report on the completion of the research surveys of 1,091 minor planets: A. O. LEUSCHNER and H. THIELE.

The conclusion of the research surveys of 1,091 definitely known minor planets and partial revision of the manuscripts for publication was announced by the authors, who have been engaged on this work under the auspices of the National Research Council with the assistance of Mrs. Maud W. Makemson as chief assistant. The purpose of this work is to lay a foundation for future research on the motions of the minor planets by collecting in systematic form all the permanent results of the investigations made by astronomers on this subject since the discovery of the first minor planet at the beginning of the last century. Only material of fundamental value has been included in the research surveys, and results of temporary significance based on approximate methods have been eliminated. The research surveys are expected to form the beginning of a new era in the treatment of the motions of minor planets. It should now be possible to attempt a more precise valuation of the various methods of perturbations which have been applied in prediction and of the effectiveness of the programs of research followed at various national institutes for the determination of the motions of the minor planets.

Tables from the year 1930 to 2020 of the perturbations by Jupiter of twelve minor planets discovered by James C. Watson: A. O. LEUSCHNER and H. THIELE. In 1910 the senior author published investigations begun in 1901 under the auspices of the National Academy of Sciences by himself, with the assistance mainly of Professor R. T. Crawford and Astronomer F. E. Ross, of the perturbations by Jupiter of twelve of the minor planets discovered by James C. Watson. At that time it was hoped that the results might remain valid until about the year 1930, when, according to past experience, a revision of the extensive calculations was expected to become necessary. However, the departures of the planets concerned, as determined for the eleven years from 1918 to 1929, have been found immaterial for all practical purposes, so that the predictions based on the Berkeley calculations are now certain to hold for many decades to come, without revision. Under a grant from the Watson Fund the tables of perturbations of these twelve minor planets have been carried forward, from the original developments, from the year 1930 to 2020.

Aztatlan: prehistoric Mexican frontier on the Pacific coast: C. O. SAUER (introduced by A. L. Kroeber). In the course of field studies in 1930 numerous and extensive unreported prehistoric ruins were observed in the southern half of the state of Sinaloa and in northern Nayarit. Thirty-two sites were visited, all of which belong to one culture province. The largest ones and the most numerous are located in the great flood-plains, or on their margins. Others occur in residual basins of Piedmont position. Still others are found in the barranca country of the highlands and on coastal lagoons. The artefacts indicate that this region was a part of the Central Mexican culture complex. Archaic elements are present in many terra-cotta figurines, which were noted most abundantly in the small upland sites. The large valley sites are of such mass and thickness of residuum as to indicate long occupation. The major part of the culture debris appears to belong to the great Toltec period. Polychrome pottery, elaborately engraved ware, obsidian knives, decorated spindle whorls and patterned cylinders are of greatest interest. In the flood-plain settlements mound building was practiced, which southward is developed into earth pyramids, apparently of sacrificial character. The culture area appears to cut off sharply north of the Culiacan Valley, though there are no physical obstacles to its expansion in that direction. No evidence was found of connection northward along the west coast with the presumably contemporaneous Pueblo culture. Two cultural sub-regions are recognized. The agricultural economy shows no dependence on irrigation. There is the suggestion that the older agriculture began on the drier lands. Everywhere it was based directly on rainfall or flooding. Present agriculture may be illustrative of prehistoric conditions. The development of agriculture in Middle America without irrigation, contrary to current assumption, is considered in the light of present practices and inferences drawn from the archeologic remains. The sites continued to be occupied into historic time as is shown by finds and also is inferred because their character and in part their position integrate very well with Spanish descriptions at the time of the conquest. The field finds confirm the Spanish accounts of extraordinary density and high culture of the native population. The existence of organized markets and of metal mining is established historically. From historical evidence the domestication of fowls other than turkeys is indicated. The fall of this culture is attributed entirely to historic causes. There is a doubtful persistence to the present of house forms, communities and linguistic elements.

Observations on the nature of the process by which mineral elements are accumulated by plant cells: D. R. HOAGLAND (introduced by T. Wayland Vaughan). Experiments carried on during recent years by several investigators prove that it is possible for plant cells to absorb various chemical elements against concentration gradients. Some experiments have been concerned with the fresh-water alga *Nitella clavata,* which produces cells large enough to be manipulated as separate units. The cell sap (containing very little organic matter) has an electrolyte concentration many times greater than that of the solution bathing the cells. Accumulation of certain ions (for example, bromine) against concentration gradients has been studied experimentally. This process has a high temperature coefficient and is dependent to a large degree on the illumination of the plant cells during the period of accumulation or on the after-effect of illumination. Unpublished data obtained more recently by F. C. Steward, using potato tissues, show that analogous accumulation of potassium and bromine may also occur in this case. However, the accumulation by potato tissue (containing stored carbohydrates) was shown to be dependent on the maintenance of proper conditions for oxidation, *i.e.*, passage of a stream of air or oxygen.

Other experiments now in progress on excised barley roots give indication that accumulation requires a supply of oxygen and that the nature and extent of accumulation is modified in accordance with the metabolic conditions existing before excision of the roots. All the present data point to accumulation as a process involving cell metabolism and energy exchanges.

On the question of the uniformity of distribution of cosmic radiations: R. A. MILLIKAN. A new series of experiments of greater sensitivity than any the author has heretofore made has been carried out and new limits have been set to the possibility of an effect of direction and of latitude on the intensity of cosmic radiations. If there is any directional effect at all it can not amount to more than 1 per cent. at the most.

Remark on the nature of cosmic rays: P. S. EPSTEIN.

Application of the Geiger-Müller Ion-counter to the study of the space-distribution of X-ray electrons: E. C. WATSON and J. A. VAN DEN AKKER (introduced by R. A. Millikan). Investigations by Van den Akker have shown that with proper precautions the new tube counters can be used for the *quantitative* study of the intensities of weak electron beams. When used in the magnetic spectrograph to replace the photographic plate they offer the following advantages: (1) greater sensitivity, (2) greater resolving power, (3) a quantitative measure of intensity. Results of a detailed study of the space-distribution of the photoelectrons ejected by molybdenum characteristic X-rays from thin films of gold will be given and comparisons made with similar results obtained photographically.

A method of calculating spectroscopic terms in shells of equivalent electrons: W. V. HOUSTON (introduced by Robert A. Millikan). For a shell of equivalent electrons one can simplify the variational method suggested by Eckart. To each electron is assigned a hydrogen function containing a screening constant as a parameter, but for the shell of equivalent electrons all the screening constants may be taken to be the same. This parameter can then be determined by the variational method. If one term due to an electron configuration is known, all the electrons except those in the outer shell may be considered as merely screening the nucleus, and the amount of this screening can be determined from the known term. The other terms due to the same configuration can then be predicted from the theoretically determined parameters. These parameters also serve to give an estimate of the spin multiplet separations.

The spectrum of carbon in the extreme ultra-violet: I. S. BOWEN (introduced by R. A. Millikan). The spectrum of carbon in the extreme ultra-violet has been studied with the aid of a vacuum spark between very pure graphite electrodes. The lines, thus obtained, have been used to extend the analysis of the structure of the carbon atom in various stages of ionization.

A study of scattered X-radiation and electron momenta with the multicrystal spectrograph: **JESSE W. M. DUMOND and HARRY A. KIRKPATRICK (introduced by R. A. Millikan).** A description is given of the multicrystal spectrograph, an instrument consisting of fifty small units, each a Seemann spectrograph in itself, cooperating to focus all their spectra in accurate superposition so as to form a single photographic spectrogram. This instrument is now being used in the study of X-radiation (MoKα) scattered from graphite at various scattering angles. It permits of obtaining spectra of scattered radiation under far purer conditions of resolution and homogeneity of scattering angle with much great contrast (freedom from background) than have ever before been obtained without demanding exposures of unreasonable durations. According to a theory of DuMond's (*Phys. Rev.*, p. 643, May, 1929) the natural breadth and structure of the Compton shifted line is attributed to the velocities—or more accurately to the momenta—of the electrons in the solid body that scatters the radiation. On the assumption that conservation of momentum and energy holds for single processes of scattering of X-radiation by electrons it was shown that the Compton shifted line should be broadened in a way similar to the Doppler broadening of spectral lines emitted by moving atoms. A relation was developed between Compton line structure and the statistical distribution of electron momenta so that given either the other could be derived. In particular it was shown that the spectral breadth $\Delta\ \lambda$ of the Compton line should increase along with the shift as the scattering angle increases, and the exact functional dependence was predicted. Experimental proof of the existence of such a dependence of Compton line breadth on scattering angle has now been obtained with the multicrystal spectrograph and is presented in this paper. The evidence, therefore, for the correctness of DuMond's assumption that the structure of the Compton line is related to the distribution of electron momenta in the scatterer seems very strong, since no other explanation of the predicted and observed functional relations between breadth, shift and scattering angle is at present available. The line structures observed in metallic scatterers constitute confirmatory experimental evidence for the degenerate conduction electron gas of Fermi and Sommerfeld, and invalidate the applicability of the Maxwell-Boltzmann statistics to conduction or "free" electrons in metals.

Artificial gamma rays produced in a 600,000-volt electron tube: C. C. LAURITSEN (introduced by R. A. Millikan). A spectrograph of the Seemann type has been constructed for the purpose of investigating the radiation from the high potential X-ray tube at the California Institute. A typical spectrogram obtained with 600 kilovolts on the tube is presented. The photometer record shows a continuous spectrum with its maximum intensity at about 200 kilovolts and a short wave-length limit in the neighborhood of 600 kilovolts. The range covered is roughly from 100 to 20 x-units. It is proposed to use the apparatus for determining absorption coefficients by photographing the spectrum of radiation which has passed through an absorbing screen. No anomalies of any kind have been observed so far.

Critical elements in study of early man in southwestern United States: JOHN C. MERRIAM. The most ancient occurrences of human remains in southwestern United States present a problem of exceptional interest by reason of the fact that the record of associated life and the details of geological history are relatively more abundant than in many of the regions of the United States where effort has been made to work out the early history of man on this continent. Frequent crustal movements in the region of the Southwest have produced extensive and deep erosion, together with wide-spread and thick accumulation of deposits. In some localities the volume of material thus accumulated, the number of strata represented in the record and the multiplicity of geological incidents arranged in sequence present a background against which projection of the record of life becomes unusually interesting. The extent to which changes in the fauna and migration of life among regions of the Southwest shows relatively large number of changes is yet to be determined by working out of details in both geological and paleontological history. There is some reason for belief that the paleontological history will show a contribution comparable to that of the geological story of the Southwest. With the background of geological and paleontological data presented it becomes of exceptional importance to make intensive study of all remains of man found in the West and especially in the southwestern area of the United States. In connection with previous studies heavy emphasis has been placed on determination whether strata in which human remains have been found are of Pleistocene or Recent epochs. For the moment it is important to learn what the historical sequence is regardless of whether the remains happen to be Pleistocene, Late Pleistocene or Recent. Once the paleontological or archeological sequences are established it will be easier to determine the correlation with stages of the Recent or Pleistocene which have been accepted as standards.

Problems of antiquity presented in Gypsum Cave, Nevada: CHESTER STOCK (introduced by F. L. Ransome). Excavations conducted by the California Institute in cooperation with the Southwest Museum in Gypsum Cave, near Las Vegas, Nevada, reveal the presence of several mammalian types, including the extinct ground sloth (*Nothrotherium*), horse (*Equus*), mountain sheep (*Ovis*), and camel (*Tanupolama?*). The better preserved remains are found in a deposit consisting in large part of sloth dung. The most striking feature of the mammalian occurrence is the unusual preservation of the ground-sloth material. The collection includes in addition to the dung the horny sheaths of claws, hair, small pieces of skin, bits of dried flesh adhering to bones, as well as skull and skeletal elements. Artifacts have been found also in the deposits. The presence of remarkably well-preserved animal remains and cultural objects leads to a consideration of two questions of major importance in the history of Quaternary life in America: (1) Was man coexistent with some or all of the animal types recorded in the deposits? (2) What degree of antiquity in Quaternary time can be ascribed to the mammalian fauna and more particularly to those types found in the dung layer? The occurrence at Gypsum Cave resembles in several respects that recorded some thirty years ago in Eberhardt Cavern, Last Hope Inlet, Patagonia.

A thermodynamic analysis of the function of the kidney; and some physiological applications: HENRY BORSOOK and HOWARD M. WINEGARDEN (introduced by T. H. Morgan). The work of the kidney in the excretion of urine is analyzed by means of the second law of thermodynamics. The work performed by the normal kidney in man in the excretion of urine is of the order of magnitude of 0.7 gm calories per cc of urine; or 70 gm calories per gram of nitrogen excreted. The production of either hypertonic or hypotonic urine entails work on the part of the kidney; the excretion of a urine which is the same as the plasma in all details incurs no work by the kidney. The energy consumed by the kidney in man in the production of urine was found to be 6–11 kg calories per gram of nitrogen excreted. The normal healthy kidney considered as a chemical machine possesses a great capacity for work but performs its work with an "efficiency" probably not greater than 1 to 2 per cent. The effect of disease is to reduce markedly the capacity of the kidney for work. This conception of renal function permits a correlation of observations on the constitution of amphibian and mammalian urine, *in situ* and isolated, in health and disease; of the effects of drugs, metallic poisons, anemia, cyanide and narcotics on the oxygen consumption of the kidney; and of the observations on the differences in renal oxygen consumption during the excretion of increased amounts of chlorides, sulfates and urea. There is a close correlation between the specific dynamic action of proteins or amino acids and the increase, over the basal level, in the urinary nitrogen. The values of the specific dynamic action of amino acids and of proteins indicate that 25 to 60 per cent. is due to the work imposed upon the kidney; the remainder is due to the metabolism of the constituent nitrogen and carbon, though it is not possible, at present, to estimate the proportion for which each is responsible. This hypothesis accounts for hitherto anomalous phenomena in the specific dynamic action of protein.

Haploid Drosophila and the theory of genic balance: CALVIN B. BRIDGES (introduced by T. H. Morgan). Some animal forms are known in which the cells of certain individuals contain only one set of chromosomes, instead of the usual two sets. These "haploid" individuals, of which the best known are in the bees and wasps, are invariably males. In *Drosophila melanogaster* sex is determined by the ratio between two sets of opposing genes, one set, tending to produce femaleness, being carried in the X-chromosome, and another set, tending to produce maleness, being carried in the rest of the chromosomes. Increasing the relative number of X-chromosomes increases the femaleness. Increasing the number of autosomes increases the maleness of the individual. A ratio (2X: 3 sets autosomes), intermediate between that of the normal female (2X: 2 sets auto-

somes) and the normal male (1X: 2 sets autosomes) gives sex-intermediates or intersexes. Since a similar relation exists for other characters, it is evident that the degree of development of a character is an expression of an equilibrium between genes tending to modify the character in opposite directions. This theory is given the name "genic balance." Now in Drosophila it was found that 2X: 2A, 3X: 3A and 4X: 4A, all 1: 1 ratios, give the female type of characters. Therefore it was predicted that 1X: 1A, or the haploid type, should be female, if the theory of genic balance is valid. No haploid Drosophilas were known, but a method was discovered which would give individuals in whose bodies, in sharply delimited regions, haploid tissue is present. These individuals occur rarely, one in many thousands, among offspring that start as Minute-n females. The gene Mn evidently affects the X-chromosome in which it lies, and to a lesser extent the other maternal chromosomes present in the same egg-cell, in such a manner that they can not maintain the normal division pace. Hence they are all rarely left behind and lost. The cells from which all maternal chromosomes are lost still contain the paternal X and autosomes and give a haploid patch of tissue. For several years attempts have been made to obtain more definite evidence, first, that these patches are actually haploid in the manner just represented, and second, to determine the sex of the haploid regions. The haploid nature of these regions and their femaleness are both now sufficiently established. One recently discovered especially favorable specimen showed in a haploid region the loss of dominant maternal characters which were carried by the three major chromosomes, here eliminated, and the presence of recessive paternal characters which were carried by the three corresponding chromosomes of the father. The sex was diagnosed as female from the darker color of the eosin eye of the region, and from the absence of sex combs, which when present are a distinctive and reliable index of maleness. The unusual nature of the case of a haploid that is female lends strong support to the theory of genic balance, on the basis of which this condition was predicted.

The inheritance of rubricalyx bud color in crosses with Oenothera lamarckiana: STERLING EMERSON (introduced by T. H. Morgan). Three types of F_1 plants, all with *rubricalyx* bud color, are produced in crosses between *Oenothera Lamarckiana* and *Oe. rubricalyx* (Afterglow). The *gaudens* complex of *Lamarckiana* with modified-*velans* of *rubricalyx* produces a plant with the *Lamarckiana* growth habit and a ring of 12 chromosomes and a pair. On inbreeding, *gaudens* · modified-*velans* breeds true for bud color, growth habit and chromosome configuration, indicating that the genes for bud color, growth habit and the zygotic lethals of *gaudens* and modified-*velans* are in the ring of 12 chromosomes. *Gaudens* with *ʰlatifrons* of *rubricalyx* produces a plant which resembles *Lamarckiana* in growth habit and has a ring of 8 chromosomes and 3 pairs. On inbreeding, it produces plants of the F_1 type and a second type which has homozygous *rubricalyx* bud color, the bud shape of mut. *latifrons*, and 7 chromosome pairs. Growth habit is variable in both types. In *gaudens* · *ʰlatifrons*, therefore, the *gaudens* lethal and the gene for *rubricalyx* bud color are in the ring of 8 chromosomes, while some of the genes for growth habit are in some of the pairing chromosomes of the F_1 plant. The *ʰlatifrons* complex carries no lethal, which accounts for the appearance of the segregate with 7 chromosome pairs. The *velans* complex of *Lamarckiana* with *ʰlatifrons* produces a plant with the *rubricalyx* growth habit and a ring of 8 chromosomes and 3 pairs. On inbreeding, four types of plants are produced: *rubricalyx*-habit with *rubricalyx* buds, *rubricalyx*-habit with red buds, *latifrons*-habit with *rubricalyx* buds and *latifrons* habit with red buds. Both types with *rubricalyx* growth habits have a ring of 8 chromosomes and 3 pairs, and both types with *latifrons* growth habits have 7 chromosome pairs. In *velans* · *ʰlatifrons*, therefore, the *velans* lethal and the genes for growth habit are in the ring of 8 chromosomes, while the gene for *rubricalyx* bud color is in one of the pairing chromosomes. The linkage between the genes for *rubricalyx* bud color, growth habit, and the *velans* lethal in certain hybrids is thus due to the association of chromosomes in the rings and not to the presence of all these genes in a single chromosome.

A spectrophotometric study of the pigments in the eye-color mutations of Drosophila: JACK SCHULTZ (introduced by T. H. Morgan). The many eye-color mutants of Drosophila furnish material for the study of problems in the physiology of gene expression. As a first step in such a study, the pigments concerned have been investigated by means of spectrophotometric measurements of their absorption curves. In the twenty eye-color types so far studied three water-soluble pigments—red, yellow and brown—have been found. The first two of these show characteristic color changes with change of pH. The brown pigment, when the solution is made alkaline, darkens, but does not change in color. All three of the pigments follow the portion of an extract which contains the amino-acids; they may possibly be related to this group of substances. Partial separation of the pigments from each other, out of mixtures, has been accomplished in various ways. On the addition of excess acid or on heating the dry pigment, both yellow and red are changed into the brown pigment, which itself is stable under such treatment. As yet the reverse change has not been brought about. The conversion of two of these pigments into the third, as well as the general similarity of their group reactions, indicates that they are closely related. The different eye-colors may be grouped into four general classes, according to the pigments they contain. Three of these correspond to the three pigments, each group containing one pigment in high concentration compared to the others. The fourth group contains those types in which mixtures of the three pigments are present. Genetic combinations have been made of mutants from different groups and the pigments present in these combinations studied. These data may perhaps be interpreted to mean that the genes involved affect the reaction which forms the pigment out of its precursor,

and that these three pigments may possibly have the same precursor.

Function space-time manifolds: A. D. MICHAL (introduced by E. T. Bell). This paper is concerned with one-parameter continuous groups of transformations and their functional invariants in the infinitely many dimensional manifold each point of which has coordinates (y (x), t).

The motion of a solid in a compressible fluid: H. BATEMAN. For the case in which the motion of the fluid relative to the solid is steady and irrotational the equations of motion may be derived from the principle that the pressure-energy of the fluid is stationary in value (a maximum usually) when the mechanical energy per unit volume is a prescribed function of the density. The pressure-energy can be expressed as the volume integral of a certain function of the velocity, and the problem has many features in common with the well-known problem of minimum area associated with the form of a soap film. The case in which the velocity of the fluid is of the same order of magnitude as the velocity of sound in the fluid is particularly interesting both on account of its technical importance and also on account of many peculiar phenomena. The theorem of Prandtl and Glauert relating to the effect of compressibility on the lift of an airfoil is extended to the case when there is a very general type of relation between the pressure and density of the fluid.

Wave motion in a homogeneous absorbing medium: P. S. EPSTEIN.

Velocity-distance relation among extra-galactic nebulae: EDWIN HUBBLE. Earlier investigations have established an approximately linear relation between radial-velocity and distance (the red-shift) among extra-galactic nebulae, amounting to about 500 km/sec per million parsecs and holding out to about two million parsecs. Thirty-four new velocities, sixteen of which are distributed among four very distant clusters of nebulae, confirm the relation in its earlier form and extend the observed range out to about 24 million parsecs. Distances of clusters and groups of nebulae are determined from the mean magnitudes, the zero-point being derived from nebulae in which stars can be seen. Extra-galactic nebulae appear to exhibit a color-excess which is independent of distance and may have its origin in the galactic system itself.

Forbidden iron lines in stellar spectra: PAUL W. MERRILL. The bright-line spectrum of the famous southern variable star η Carinae was well known to astronomers for many years but until recently numerous strong lines remained unidentified. The same lines had been observed in a few other stellar spectra. Shortly after Bowen announced the discovery in the spectra of nebulae of so-called forbidden transitions from metastable states of oxygen and nitrogen atoms, the lines resulting from similar transitions in ionized iron atoms were computed and found to coincide with most of the strong unidentified lines in η Carinae. An essential distinction between these lines and those known in the laboratory is that the probability of spontaneous transition from the initial (upper) state is much smaller. They correspond to quadrupole rather than to dipole radiation. The forbidden iron lines are now known in about twenty stars, including eight or ten associated with class B, one or two of class G, three or four long-period variables just before minimum light, five other red stars and two novae. The spectrum of H.D. 190073 exhibits numerous bright iron lines, although the forbidden lines are apparently absent. It is of especial interest, however, because of the presence of bright sodium lines. Aside from novae this is the first star in which these familiar lines have been observed to be bright.

Mount Wilson measures of lunar and planetary temperatures: EDISON PETTIT and SETH B. NICHOLSON (introduced by Walter S. Adams). The temperature of a planet is given by the general equation $\log T = 2.612 - 0.1 (\overline{m}_r - \Delta m_r)$ where $\overline{m}_r$ is the radiometric magnitude of the planetary heat per square second of arc, and Δm_r is the absorption loss in the atmosphere and the telescope. The radiation from each planet was measured with a thermocouple placed in the principal focus of the 100-inch reflector; the radiated planetary heat, from which $\overline{m}_r$ is obtained, was separated from the reflected sunlight by means of a thin glass absorption screen. The atmospheric absorption was derived by extrapolation from Fowle's laboratory measures of the transmission of water-vapor and from a comparison of measured and computed maximum temperatures on the moon. The radiation from the moon was measured during a total eclipse, and from the rate of cooling some idea of its heat conductivity was obtained. The resulting temperature of the sub-solar point on the moon was 374° K, and of a point on the night-side, less than 120° K. The temperature of a point where the altitude of the sun was about 20° fell from 342° K before the lunar eclipse to 156° K after 2^h 40^m immersion in the umbra of the earth's shadow. The maximum temperature of Mercury is about 655° K. The distribution of radiation over its surface is much like that on the moon. Venus is covered with clouds and the radiation measured is from the high cloud surfaces and, except by inference, tells very little about the actual surface temperatures. The measured night temperature on Venus is about 241° K which is much higher than that on Mercury or the moon. The temperature on Mars varies greatly with the season and the time of day. With the sun in the zenith at perihelion it measures 296° K; at aphelion this temperature would be reduced 27°. The outer planets are very cold, as might be expected from their great distances from the sun, unless they give off heat from their interiors. The thermocouple measures show that the temperature of Jupiter is about 135° K and, therefore, that very little of the radiated heat comes from its interior.

The photochemical reaction of gaseous iodine with hexene, and the separation of the two types of iodine molecules: R. M. BADGER and J. W. URMSTON (intro-

duced by A. A. Noyes). It was the purpose of the experiments here reported to attempt a separation of the symmetric and antisymmetric types of iodine molecule by means of a photochemical reaction in which one of these molecular types is selectively activated. The selective activation was effected by irradiation with the green mercury line, 5461 A, which is absorbed by only one of the molecular types, and the acceptor chosen for the activated molecules was gaseous hexene. If the photochemical reaction were of the simplest kind, namely the addition of the activated iodine molecules onto the hexene double bond, the reaction would proceed until half the iodine is used up, the molecules remaining being of the type which does not absorb the green mercury line. Experiments on mixtures with a partial pressure of iodine of about 0.17 mm and of hexene of about 6. mm show that the mechanism of the reaction is actually more complicated, and may possibly involve energy transfers between the two types of iodine, or the production of iodine atoms at some stage of the process. However, fluorescence experiments on mixtures in which half the iodine had reacted indicated a small but definite excess of the molecular type which does not absorb the 5461 A line, over that found in the equilibrium iodine mixture. This excess does not disappear in several days when the gas mixture is kept in the dark.

The ring structure of mannose: HORACE S. ISBELL (introduced by George K. Burgess). The ring structure of the various forms of glucose and mannose has been the subject of considerable controversy. It has been claimed (Hudson, *Jour. Amer. Chem. Soc.*, 52: 1682, 1930) that a decision between the rival classifications of rings might be obtained from a comparison of the optical rotations of a pair of sugars which can exist only in one ring form. Two pairs of substances which fulfil these requirements, cellobiose and 4-glucosido-mannose, and lactose and 4-galactosido-mannose, were pointed out by C. S. Hudson. A comparison of the approximate rotations of these sugars as given in the literature shows that the difference between the molecular rotations of the first pair differs widely from the value obtained for the second pair. Thus it was necessary to obtain more accurate data upon the rotations of these substances. The preparation of 4-glucosido-α-mannose monohydrate has been repeated and the initial rotation as extrapolated to zero time was found to be $[\alpha]_D^{20} = 14.6$. A comparison of the molecular rotations of cellobiose and 4-glucosido-α-mannose gives an "epimeric" difference of 16,900. This is of the same order of magnitude as the values obtained from α-mannose and α-methyl mannoside, 14,900 and 15,300, respectively, but it differs markedly from the value 6,700 obtained from β-mannose. On the other hand, a comparison of the approximate rotations of 4-glucosido-β-mannose and 4-galactosido-β-mannose indicates that they agree with the value derived from β-mannose. These results are interpreted as indicating that 4-glucosido-α-mannose has a structure similar to α-mannose, while 4-glucosido-β-mannose and 4-galactosido-β-mannose have structures similar to β-mannose. Since the disaccharides just mentioned can not form a 1, 4 ring, probably neither α- or β-mannose has a 1, 4 ring structure.

Crystalline alpha and beta methyl-d-gulosides: HORACE S. ISBELL (introduced by George K. Burgess). The reaction between reducing sugars and methyl alcohol in the presence of hydrogen chloride gives a mixture of isomeric methyl glycosides. Frequently amorphous products are obtained which can not be brought to crystallization by the usual methods. The separation of two isomeric methyl gulosides from such a mixture was accomplished by means of crystalline coordination compounds with calcium chloride. So far as known these compounds are the first compounds of this type to be prepared from the methyl glycosides. The calcium chloride was removed by means of silver oxalate, and crystalline α-methyl-d-guloside (monohydrate) and β-methyl-d-guloside were obtained for the first time. The following new compounds are reported:

α-Methyl-d-guloside $CaCl_2 \cdot 2H_2O$,	$[\alpha]_D^{20} = +67.$
(α-Methyl-d-guloside)$_2$ $CaCl_2 \cdot 3H_2O$,	$[\alpha]_D^{20} = +83.$
α-Methyl-d-guloside $\cdot H_2O$,	$[\alpha]_D^{20} = +109.$
β-Methyl-d-guloside $CaCl_2 \cdot 2H_2O$, (approximately).	$[\alpha]_D^{20} = -46$
(β-Methyl-d-guloside)$_2$ $CaCl_2$,	$[\alpha]_D^{20} = -65.$
β-Methyl-d-guloside,	$[\alpha]_D^{20} = -83.$

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STANDARDIZATION VERSUS MEDICAL EDUCATION[1]

By Dr. CHARLES R. STOCKARD

CORNELL UNIVERSITY MEDICAL COLLEGE

THE very agreeable task has fallen upon me to welcome you here to-day. When welcoming strangers, newcomers or initiates into one's castle or into one's clan it seems to me both cordial and fair to openly consider what manner of place it is to which you are being welcomed and to presume something as to why you seek welcome here. The simple tone of welcome does not always indicate the kind of consequences to follow—some of you may recall the very gracefully poetic invitation of the spider to the fly.

This place is one of those ancient human arrangements in which a group of somewhat mentally mature and experienced persons undertakes to encourage and lead a larger group of youthful aspirants into the knowledge and methods of a learned profession. This kind of arrangement has been jealously perpetuated throughout the generations of human history to be handed down to us. It has been accepted as necessary in the existence of tribes, kingdoms, empires and free states. And it belongs to that order of things commonly called schools.

[1] Address delivered at the opening of the session of Cornell University Medical College, New York City, on September 29, 1930.

All of you have had far beyond the average experience in schools, and in this place you are not altogether strangers. But have you stopped on the threshold to ask yourselves what differences there are between this place and the schools you have already attended—and, more important still, what are the different reasons for your having been in the different grades of schools? All schools are not alike and we attend each for a different reason to ourselves and to the state.

Attendance in the elementary school is compulsory and is demanded by almost all enlightened governments. The state requires and supplies a certain amount of education. But, as in the case of most things forced upon us, the child frequently assumes that he is attending school for the state or the law or surely for some one other than himself. In the ele-

mentary school and our high school learning is a forced performance and the idea in the mind of the pupil is that he is studying and working for the accommodation of the teacher. If he likes the teacher he studies and, if not, he avoids it. The teacher is often heartily disliked and learning is an arduous imposition.

Our American colleges are quite different in many ways from the elementary schools. Attendance in college is not required by the state. Yet most of the states have recognized that this is a degree of education which should be available for those citizens who desire it, and many states of the Union maintain colleges where such education may be had without cost for tuition. However, no state has seen fit to require or force the college attendance.

The college is thus presented as an opportunity to be freely chosen—a luxury in education. In spite of this fact a carry-over from the compulsion of the elementary system, together with the urge of the pretentious parent desiring a college attendance for his immature son, keeps alive the early attitude that education is taken for the good of the state, the pride of the parent or something other than the high advantage to the student himself.

In speaking of college education I am timidly referring only to that precious but inconspicuous and almost submerged effort for academic learning, and not the booming rah-rah spirit and intercollegiate athletic mania so out of proportion and out of harmony with any intellectual pursuit.

Finally, after finishing college as the highest of the preliminary educational experiences the person is faced with the problem of employing himself in the community. He feels the need of a knowledge of how to do something! He learns that there are professional schools for the higher activities of engineering, art and music, and schools for theology, law and medicine—the so-called learned professions. No state forces on its citizenry an education in such schools. Very few, if any, states provide such education free of some tuitional cost to the student. Few ever so haughty parents attempt to force this class of education on their resistant sons.

These professional schools along with the departments of pure science and scholarly research constitute the universities or institutions of higher learning. In such places as these the atmosphere, by which one may mean the attitudes of teacher and pupil, should become entirely changed from that of the elementary grades.

The pupil is no longer impounded by the state or forced by the parent to do this task, and the teacher is no longer the officer of the state or the agent of the parent to see that the task is done. Now at last the student is an independent individual forced by no one to seek an education preparatory for his life profession. The teacher now becomes a dependable and encouraging worker associated with the student. Such a teacher should be an established scholar and investigator in his own field with an impulse to lead and direct the activities of less experienced students who have an aim to function in ways related to the teacher's intellectual interests. These teachers must lend themselves to be a source of inspiration to their students. They are often men of eminent distinction in science and learning and of international reputation in their sphere but at the same time without possessing even local notoriety. The man on the sidewalk has never heard of them. It is this contrast between the attainment of actual distinction and the craving for ordinary notoriety that sets the scholar apart from the "movie-star."

The scholar is self-sufficient. He need never be lonely and is never idle. The notoriety seeker is dependent upon the crowd—alone he is completely insufficient and out of the sight of others he is generally idle.

The true university in all its branches is the haven of scholars. They alone are at home here, and no one else is altogether comfortable. The place is inspiring and every one strives to take advantage of its privileges which so few of the human inhabitants of this globe are capable of enjoying. Let us hope and be bold to trust that this school is a part of such a university.

So much then for the nature of the place in which we gather to-day.

We may now become more specific in a brief consideration of the recent conditions in the American medical school. During the first decade of this century, only between twenty and thirty years ago, there was no crowding excess of students in our colleges or medical schools. On the contrary, members of the faculty frequently spent parts of their summers in traveling around drumming for students. The graduate schools of the universities at times offered more scholarships and fellowships than could be filled even after seeking for applicants.

The medical schools were fully developed in only a few places. Most of them were far behind in facilities and inadequately organized. The poorer ones drew students more easily than the better ones and all spent time and effort in trying to persuade students to come. There were very few requirements for entrance and almost any one could be admitted. This medical college accepted high-school graduates and took all comers, as did almost all others, and had classes of something less than a hundred students.

The medical schools and colleges before 1914 were

open and almost unregulated and so was travel and general behavior. It was an unstandardized and unregulated period.

Some medical colleges required one thing and some another and many had no connection with a university or a general educational institution at all. These stood alone as a weed in a desert and wrote diplomas in their own name as acceptable documents in the community. Any one could attend, and almost any group of doctors could conduct a medical school.

During this same time any one who had it could fill his purse with the coinage of almost any country, board a ship and sail away to almost any port without a passport, without a letter of credit and without any questions as to where he was going.

Any one during this time could walk into a grocery store or a wine store and order whiskey, wine or beer by the bottle, case or carload and it would be simply delivered at his home with no more question or surprise than is the delivery of a pound of coffee nowadays.

And all these ways in education, travel and barter were the general fashions less than twenty years ago!

But do not imagine for a moment that this was a time of pandemonium—quite the contrary. It was merely the time before organizations assumed an extensive responsibility for personal behavior. Drunkenness was little if any worse than now, particularly among the respectable classes; crime was modest and shy, and there was no occasion for a government commission to study the violations of law. There was also no exalted commission on medical education.

Under such conditions what was the state of mind of the medical students? Naturally it was rather free. They had come to the medical school because they wanted to and were interested in being a physician or a surgeon or a medical scientist. Certainly they did not come because it was the fashion or the thing to do, for it wasn't. Whether they attended all classes or how much work they did was no one's worry. When the time came students were given an examination and often as high as 30 to 40 per cent. of the class would fail. Those who failed simply repeated the course for the next year or so until they passed or else they left for some other school that asked few if any questions and was glad to have them.

This state of affairs was not altogether so bad as it sounds, for there were good medical schools as well as bad ones and many good students were in all of them. These men to-day are a credit to the very top of their profession in various lines.

What the situation very evidently needed was a little brushing upward and many influences began to work toward tearing the bottom off in some cases and pushing it up in others. This started well and within the short space of a few years between 1909 and 1915 almost all the actually harmful and unfit medical schools of the country were closed and out of business.

This surprising result was largely due to a masterly survey and discussion of American medical education by one able man. However, the fine start, as is often the case, obtained a bit too much momentum and swept out into the national organizations and committees. These became very busy but only succeeded in bringing about the present-day fashionable craze of standardization and regulation of all thought and fancy in medical education.

The Association of American Medical Colleges assumed new importance. The council on medical education of the American Medical Association began to flourish as never before. An epidemic of curricula prescription writing swept the country's map. A certain dose of so many hours was prescribed for all growing medical students in anatomy, chemistry, physiology, pathology and even in medicine and surgery. There was generally a minimum and maximum dose allowed, depending perhaps upon the constitution of the school and the maturity of the student.

It was not realized that getting rid of disgracefully bad and inadequate schools was one thing which need not inflict any regulation whatever on the composition and performance of the best schools.

Finally, the medical schools have reached back into the college to require a definite premedical training of so many units in biology and physics, chemistry, etc. The number of college units of credit is naturally easily calculated, and the units are what count rather than the more difficultly ascertained quality of experience and inspiration which the college education has imparted.

Having secured the premedical requirements a vast number of students now apply for admission into the sanctum of the medical school which to them seems quite formidably guarded. Nearly a thousand persons apply for the privilege of being the seventy to constitute the first-year medical class. The selection is rigid and all must pass muster on their school records, their premedical units, their personality and other qualities. Finally, the door is open to the selected few and they enter in with fear and trembling lest they once fail to pass a few courses and are dropped out, never to have a second trial, and with slender prospect of being taken into another fold. Under these conditions every one does not work merely for the joy of learning but oftimes only for the necessity of passing. The course becomes a

crowded grind and the inspiration and glory of simply doing becomes a faraway phantom.

The course is often regulated and standardized to such an extent that every one is trying to do exactly the same thing in the same time and to beat the other at doing it. This is irrespective of individual tastes, talents and personalities. These various personalities are swamped in the uniformity of things, and intellectual tolerance and truth are difficult to hold in the spotlight of advance. This is contrary to nature and so peculiar situations have arisen. One of these I may relate as having occurred in a far distant part of the country.

A medical school conducted along the usually regulated plan found that cheating on examinations had become a rather general and accepted practice among the students in spite of the existence in the school of the so-called honor system. The faculty became disturbed on realizing that things were not exactly as they were ruled to be. The dean of the faculty conferred with a group of the senior students to discuss the situation. He learned that the students agreed that if all those who cared to should cheat it would be as fair for one as for another, and the sad predicament of being dropped from the school might be avoided by some and reduced to a helpless minimum.

The dean was somewhat surprised at this rather broad and philosophic attitude, but he felt that the students were chiefly at fault. He propounded a further question as to their plan of behavior and asked whether they, who had decided cheating was proper, would steal another's instruments or clothing. The students replied that none of them would steal, and they held stealing to be a crime. The dean and students acquiesced in the idea that stealing was a greater vice than cheating or lying.

This of course was surprising to members of a scientific group, who had come to realize that truth was the supreme virtue towards which all students of natural science must aspire. Questions of ownership and property rights are social and artificial, and changes in the system cause no mental confusion. We know exactly what has occurred and what we have. One person had in his possession a material thing which another person has temporarily taken for his own. But when one relates an occurrence or records an observation as having been other than it truly was we are misled and mentally confused. If this was a general practice we could scarcely become acquainted with the world about us. In medical science as in all science there must be a never-failing search for fact or truth. One must depend upon the truthfulness of others in order to advance knowledge in the conquest against disease.

If an experimental investigator reports a given drug to bring forth a definite physiological response which might be of high clinical importance, the clinician must depend upon the truth of the report and if it be false it may mean the death of his patient. Persons who must in practice apply truths and facts as they are given to them are not the people to tamper with deception and falsehood during their years of education and training.

We must now ask ourselves whether a system of standardized regulation does promote a search for truth and does really enthrone truth among its gods.

When a number of persons, all differing in their past experiences, tastes, knowledge and desires, are forced into a system demanding a uniform performance they intuitively feel the contrariness to natural truth in the plan. Individuality is embarrassed and originality is discouraged and the routine of the machine is glorified. This promotes cheating and finally, as we have seen, may carry the vice through the stages of endurance, pity and embrace.

When cheating becomes general it is the fault of the situation and not alone of the persons concerned. If this be a situation in scientific education it must be promptly changed and made over or the aim for which the system was intended will be forever lost.

The student comes to the medical school as an adult individual to work for himself and to learn his own job. His behavior should be regulated by the system as little as possible and he should be given every proper opportunity to use his own initiative, his own discretion and his own way in securing for himself the knowledge and skill he needs in his profession. If the opportunity for free action and choice be completely denied him by a system of standardized uniformity how can it ever be expected that this person will later be original, resourceful and ingenious in the handling of human patients or the solving of medical problems? It is as much a part of education, and especially of higher education, to learn how to direct one's self independently as to accumulate knowledge from laboratories and books.

Lectures, demonstrations, laboratories and clinics should be available, but only the most formal part of these should be scheduled by time. A student should be free to work as short or as long a time as he finds necessary for an understanding of the particular problem or subject. Certainly no two intelligent individuals can quite do the same thing equally well in exactly the same time. A student should, therefore, have some right in deciding when he is ready to be examined for qualification in a subject. All this latitude is perfectly possible and is being practiced in parts of the university and to some extent in medical schools in several parts of the world.

Some one may say that many students are not adapted to such open arrangements as this—I agree that they are not, but I would also add that they have no business here and the community would be indebted to us if such persons were unable to crawl into the medical profession. No one should be carefully checked for attendance, quizzed and drilled on lectures and texts and watchfully guided through laboratories and clinics for four years, and then be suddenly let go to stand on his own feet and independently treat the sick and dying.

The champions of fairness to the weak and deficient student have had far too much influence in the moulding of methods and arrangements in the medical faculties. This vision of fairness should be a little more far-sighted and look away to the lame doctor attempting to treat the crippled patient at the other end of the line. There might be a picture hung beside the rear exit door of a medical school showing a bungling, inefficient person pretending to cure a sick patient, and for those admiring symmetrical hangings an appropriate sister painting could portray the proverbial blind leading the blind.

No, there can be no welcome here for bungling, sloppy-minded or incapable persons—the medical college is not the place for them. And a consideration of such persons should not enter into the design of our educational policy. The policy must consistently avoid penalizing the able student in order to salvage the unable; it must be built only for him who stands.

We do not propose a simple turn-back to the old open system of ante-bellum days which so many of us experienced. This would get us no further along. But we do urge as the essential elements in human education open-mindedness and intellectual tolerance. Education in all fields of science should break down prejudices, promote tolerance and force with unerring determination the quest for natural truth. This has never been approached on any system of standardization. Uniformity and standardization immediately establish a prejudice against deviation and false ideas of perfection arise. Tolerance and truth have little sanctity in such a communion.

We here have aimed to have an institution in which an understanding of life may grow. The consideration of facts as we know them and the search for new facts is to be our daily privilege. To differentiate fact from fancy and to become adamantine in our determination to make no mistake between them is to be our discipline. Human minds frequently accept wide categories of things as facts. But the free admission of half-established findings to the realm of facts is the most befogging reaction of the brain. The more cautious one becomes in accepting an apparent fact the more reliable he becomes as a scientific scholar.

The struggle for truth must be consistent and universal. And self-deception must be as fully and as carefully avoided as the deception of others. No one can deceive himself without sacrificing his only method for obtaining the truth.

To these aims and to your part in their accomplishment the faculty of Cornell Medical College heartily welcomes you!

HOW THE COLLEGE CAN AID THE OYSTER INDUSTRIES[1]

By Dr. DONALD W. DAVIS

PROFESSOR OF BIOLOGY, COLLEGE OF WILLIAM AND MARY

The story is told of Alexander the Great that as a young man he watched the efforts of his father's subjects to tame an exceptionally fine horse, and noticing that the horse shied at its shadow and obtaining permission to attempt to ride him he faced Bucephalus toward the sun and forthwith had him under full control. The obvious moral to this tale for the two organizations meeting here to-day is "know your oyster." It is possible that some of the many unexplained difficulties encountered by the oysterman are due to the oyster shying at its shadow, and only an observant Alexander is required to orient him properly. But, unfortunately perhaps, the oyster in the earlier stages of its life cycle is very small and elusive, difficult to find and to see without special aids. Furthermore, the source of the shadows interfering with our control of the behavior of the oyster are obscure. Its food is exceedingly minute, and the physical and chemical balance in its surroundings necessary for its complete and rapid development is most delicate. So that knowing your oyster adequately for satisfactory control requires use of the microscope, the test-tube, the salinometer, the balance, the kymograph and most of the rest of the physical, chemical and biological equipment of our biological laboratories. It requires also the mind trained in interpreting the revelations of these aids

[1] Read before the annual convention of the National Shellfisheries Association, Sayville, Long Island, August 19, 1930.

to our senses. I do not wish to suggest that such a personality as that of Alexander the Great is required to solve our problems and to apply the knowledge thus acquired to the business of oyster production. Barring the few who have defects of eye or hand or mind that positively and seriously interfere with the use of one or more of these instruments in the prosecution of observations or experiments, any member of this audience can train himself to do this work if he has the will and the time to do so. That is, by and large any member of this group may if he will qualify himself as a biologist for the study of oyster problems. In doing so he will study physics and chemistry, the structure and behavior of the oyster and its relatives, its food and its enemies; he will need to practice in the use of the experimental method and its tools. In a word, he will find it necessary to go through just such a program of rigorous training as is provided in our schools and colleges for the training of young men for scientific work in various fields. I would not be so foolish as to urge that every member of the organizations meeting here make this attempt. Actually and for numerous good reasons very few will do so. Obviously, for most of those present the important thing is to see and to know the work of the biologist sufficiently to utilize the particular skill he has acquired in the solution of problems to which that skill is requisite.

The problems to which the biologist interested in oyster production addresses himself are of three kinds. One is that of original discovery, of research, finding new significant aspects of the life history of the oyster or of its food or of its enemies or of the relations to other features of the environment. This is comparable with the discovery of new processes in a chemical industry on which modifications of procedures may be based. Studies of this sort make possible profitable application in regions far from the place where the research was done. Another kind of problem is concerned with adaptation of the results of fundamental research to local situations. A few bushels of experimental demonstrations may save boatloads of losses. This type of study involves much the same methods as the first and leads to further research of the first type. It also points toward the third type of study. This may be referred to as control study, routine tests of conditions for which standard procedures have been established by studies of the preceding types. These tests should be made as widely as possible in oyster-producing areas as checks on established methods and as guides to current local practice. These tests also may lead to further studies of the other types. Parenthetically it may be readily admitted that oysters may be produced with profit without such services as I have indicated. We all know of persons who are successful in various activities in spite of their disregard of modern aids and methods—from the sailor who senses his channels and needs no buoys or lights to the cook who skilfully judges the amount of various ingredients and scorns to weigh or to measure. But the number who develop such skill is too small for present demands, and the losses by these methods from the failures of the less competent are too great for our times. We are committed rightfully to the plan of marking our channels and providing our kitchens with scales and measures. Surely the oyster industry is not one to be exempt from the need of such aids. Judgment is, and will always be, a most important factor in oystering. The work of the biologist in the oyster industry is not to render judgment unnecessary but to provide a significant basis of information on which more reliable judgment may be based.

It seems clear, then, that in oyster production there are unsolved general problems and local situations requiring investigation and control by men trained in the use of scientific methods. The function of the college and the university in conducting such studies and in training men for such work is better recognized in some other industries, but that they have their part in our industry is unquestionable. The presence on this program of papers presenting results of just such studies as I have suggested by men working at universities or trained in them and the presence of other speakers representing institutions noted for their contributions to this and other industries abundantly evidence the aid these institutions may give to the oyster industry. Lest I do injustice by omission or emphasis in the more complex situation within our industry let me cite by way of illustration of the closeness of the universities to industrial investigations the series of studies on fresh-water mussels. Some of you doubtless heard M. M. Ellis review this series before the American Fisheries Society a year ago in Minneapolis, and others have read his address published in the *Transactions* of that society. In 1866 the German zoologist, F. Leidig, then at Tübingen University, demonstrated that larvae of the fresh-water mussel live parasitically on the gills of certain fishes. Lefevre and Curtis, of the University of Missouri, artificially infected fishes with mussel larvae. Arey, of Northwestern University, studied the relation of the larvae to the tissues of the host. Now Ellis, of the University of Missouri, carrying further the series of investigations, has succeeded in raising mussels without intervention of the troublesome fish host and has given new promise to a seriously depressed industry. These men are all university trained and all have carried on their work while

serving in a university connection. It would be unfair as well as ungracious to fail to mention in this connection the essential part played by the U. S. Bureau of Fisheries in these studies. If I am not mistaken all except one of the American investigators mentioned has carried on his mussel work under part-time appointment of the bureau. The stimulating and coordinating function of this and other agencies outside of the academic institutions as well as their function in actual conduct of investigations must be fully recognized.

It is not my purpose here to discuss in detail the part to be played by different agencies in promoting the studies suggested. Some may best be prosecuted by the colleges or universities or by men in their services. In other cases it is better that governmental agencies directly employ investigators, while more and more it is to be expected that those engaged commercially in the industry will cooperatively or individually find it to their advantage to employ full-time men on their particular problems. Examples of all these methods are familiar to you all, and selection of a favorable relation for any particular need and budget possibilities should not be difficult. In presenting the possibilities of usefulness to the oyster industry of the colleges and universities I should, however, point out certain advantages of having researches in the interest of the oyster industry in close touch with college or university. In the first place, in these institutions much in the way of overhead expense is already taken care of and need not be a charge on the investigation; much equipment is already supplied and much in the way of advisory and consultative service in various departments is available at little or no cost. Again, the service of student apprentices or assistants can usually be obtained at small expense. By such relations the institutions are stimulated to offer courses needed for improved training of these assistants and of others whose interest is stirred by their work. These intimate relations result not only in more and better trained men in general but trained men with some interest and acquaintance in the specific problems of the industry. I think it is not too far afield to claim even that there is actual if not measurable advantage to the industry through contacts of those interested in it with those in the colleges not otherwise in touch with this particular industry. The oyster industry has often suffered from the lack of sympathetic acquaintance on the part of those, constituting the great majority of the citizenship of the state, who live beyond the limits of tidewater. Anything that contributes, as I maintain the college and university do when carrying out studies in association with a great industry, to dissemination of a sympathetic interest and acquaintance with its problems is far from negligible. I believe many of us could testify as to the broadening effect on our interest and sympathies of such college and university contacts.

Now while I recognize well that the independent spirit of those in the oyster industry makes the suggestion peculiarly little needed, it may avoid misunderstanding in some quarters for me to point out that the undertaking of studies of value to the oyster industry by academic institutions or by men in their service is usually possible only when agencies concerned in the industry contribute more or less of the expense of the investigation. The colleges and universities already have a full program, and their staffs are in general well loaded with previous undertakings. If those engaged in an industry themselves recognize no need of services from these institutions, that industry stands small chance of having the institutions or individuals belonging to them, unasked, step in to formulate and solve their problems or to set specifically about training those who will. The relation is one dependent for success upon close cooperation and a pooling of facilities and resources in order to accomplish objects of value from the standpoint of both industry and education.

But in listing the offerings of academic institutions to the oyster industry, I should not confine myself to that large phase of the industry concerned with production. Rapid advances in means of distribution, in methods of preservation, packaging and handling have brought into prominence problems connected with these aspects of the industry, and here too specialists for investigation and control are demanded. For these too the colleges have provided fundamentally trained men. They will doubtless be called upon to supply technologists more fully trained and in greater numbers in the future.

With the increase in size of the units engaged in production and distribution, with closer cooperation among the units concerned and with heightened interest of the state and national governments in stimulating and coordinating the activities of this and related industries, the demand for qualified administrators is advancing. The trained administrator (whether trained wholly in service or in part in an academic institution) is one who, while not necessarily skilled in the various techniques, is broadly acquainted with the methods in use and with their possibilities of development, familiar with types of organization and with business procedures. Various elements in this training are now given in the colleges. Coordination and extension of the training along this line may be accomplished.

Various limitations prevent my taking up in detail the academic facilities for training men along the

lines mentioned, but, in closing, I want to make one further suggestion. Young men already possessing close acquaintance with oyster industries are going to college and on into graduate work of the universities. Other things being equal, they start with great advantage over other men who may take the training I have mentioned as marine biologists, technologists or administrators in the oyster industry. I believe that they may well plan to get in college and in the university, among other objects of their desire, knowledge and training of special significance to them in connection with a life devoted to the commercial oyster industry. Let us have in the institutions as much as may be of your problems to set before the young fellows who will go into the oyster industry. For success in the future, they must go into various aspects of the business equipped to see deeper than oystermen have seen, to know more fully than they have known. Give these fellows the best that practical oystermen can give them and send them to college with the will to see and to know—and among us we'll make another generation of real oystermen.

OBITUARY

RECENT DEATHS

DR. HERBERT H. DOW, president of the Dow Chemical Company at Midland, Michigan, died at the Mayo Clinic on October 15, at the age of sixty-four years.

DR. HENDRIK ZWAARDEMAKER, professor emeritus of physiology at Utrecht, died on September 19, at the age of seventy-three years.

ALEKSY ALEKSANDROVIC KULJABKO, professor of industrial physiology, died at Moscow on August 6.

MEMORIALS

THE forty-fifth annual convention of Tau Beta Pi, engineering fraternity, in session at Lehigh University on October 11 dedicated a memorial to Dr. Edward H. Williams, Jr., its founder. This marks the forty-fifth anniversary of the founding of the fraternity at Lehigh in 1885. Dr. Williams was professor of mining engineering and geology at Lehigh when he founded the organization, retiring several years ago. The memorial, which will consist of a bowlder with a bronze tablet, will be placed in front of Williams Hall on the campus, which building was the gift of Professor Williams many years ago.

AT Colgate University the new chemical laboratory, built at a cost of $500,000, will be dedicated on October 31 and November 1. Funds for the erection of the building which is named in honor of Professor Joseph F. McGregory came from Dr. James C. Colgate, chairman of the board, and from the estate of Miss Evelyn Colgate. For forty-three years Professor McGregory was head of the chemistry department at Colgate.

IN memory of the late Stephen T. Mather, first director of the National Park Service, an oak tree was planted at the old Mather homestead at Darien, Connecticut, on October 19. Planting of trees in honor of Mr. Mather has been carried on throughout the country, singly and in groves, in widely separated portions of the country. One memorial forest of 10,000 trees was planted by the State of New York. In each of the national parks a single memorial tree was planted on July 4, Mr. Mather's birthday, by uniformed park rangers. Plans are also under way for plantings in the southern states when weather conditions are most favorable.

THE *Journal* of the American Medical Association notes that a group of physicians of the region about Pau (Basses-Pyrénées) celebrated recently, in that city, the memory of their compatriot, Dr. Duboué, and had affixed to his home a tablet setting forth the stages of his career. The ceremonies were presided over by Dr. Doléris, member of the Academy of Medicine and a native of this region. He recalled that Duboué, in addition to his research on typhoid and cholera, had been the first to discover that the virus of rabies finds its way from the initial wound to the brain by way of the nerves and not through the blood stream. His work was published in 1879. It was two years later that Pasteur read to the academy his own work on rabies, in which he recognized the priority of Duboué.

SCIENTIFIC EVENTS

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE British Association for the Advancement of Science has recently concluded a most successful meeting at Bristol, at which discussion has taken place as to the arrangements for the centenary meeting, to be held in London, with the gracious approval of H. M. the King, patron of the association, and under the presidency of General Smuts.

The association during its first century of existence may claim to have established itself, first as a national and more lately as an imperial institution. Its council is of opinion that, despite the steady support which it receives from its members, and the generosity

of certain individual benefactors, and of those home cities or dominions which from time to time entertain it for its annual meetings, the power the association has acquired for the advancement of science might be far more effectively exercised if it possessed a larger endowment. The council would be loath to risk narrowing the present wide field of membership and therefore of interest and usefulness by increasing the subscription for the annual meeting, though that still remains at the figure of one pound at which it was fixed in 1831, and has even been recently reduced to half that sum for junior student members. The council has therefore decided to appeal for a centenary fund of £40,000.

A first charge upon that fund or the income from it must be the expenditure appropriate to the fitting celebration of the centenary itself. In this connection it is the object of the council to make the centenary meeting an occasion for the gathering of the largest possible representative body of scientific workers from the dominions, and by this means to repay something of the debt which the association owes to those dominions whose hospitality its members have enjoyed.

Beyond this immediate object the association earnestly desires to maintain and extend its annual financial support of scientific research, to discharge fittingly the trusteeship of Darwin's house at Downe, recently entrusted to it in custody for the nation and indeed for the civilized world, and to assure the means of carrying out its imperial responsibilities. Its financial constitution has always forced it to live in a measure from hand to mouth.

The contributions towards research from the funds of the association fluctuate annually with its net balance of receipts over expenditure, and it is therefore often a matter of chance whether the association is able to support any particular research in accordance with its intrinsic importance. Not infrequently the association has to count the cost, with too much appearance of parsimony, before accepting an invitation to a particular place, having regard to the prospects of local support, or to the distance and expense involved for members who attend. Where the association is summoned to carry on its public mission, there the council feels that it should be able to go without question or limitation on financial grounds.

Those who serve the association by contributing to its program, carrying out its researches and organizing its reception at successive places of meeting, do so voluntarily, and it has been said that to voluntary service in the interests of science the whole story of the British Association stands as one great memorial. The object of the present appeal is to strengthen the organization which makes use of that service.

Contributions to the centenary fund will be gratefully acknowledged by the General Treasurer, British Association, Burlington House, London, W.1, and it is competent for donors to hypothecate their contributions, if they so desire, for research in any particular department of science or for any of the objects which have been indicated above.

F. O. BOWER, *President*
J. C. STAMP, *Hon. General Treasurer*
JOHN L. MYRES, } *Hon. General Secretaries*
F. J. M. STRATTON, }
O. J. R. HOWARTH, *Secretary*

THE BRITISH PARASITE LABORATORY

THE London *Times* reports that delegates from twenty-two British Empire countries who attended the Imperial Entomological Conference visited the Farnham Royal Parasite Laboratory, Buckinghamshire, which was founded by the Imperial Bureau of Entomology in 1927, by means of a grant from the Empire Marketing Board, to further the control of insect pests by the biological method. The visit gains topical interest by the publication of "The Biological Control of Insect and Plant Pests," which contains the first full account of the work at Farnham Royal.

The "Parasite Zoo," as the laboratory has been called, is a converted country house used as a clearing station and breeding center for "beneficial" insects. These are dispatched to the Dominions and Colonies to attack the pests which cause enormous loss to plant and animal life. The good insects are parasites, and control the bad insects by laying their eggs in or on the pest's grubs and eggs, and then by feeding on them. In the three years of its existence the laboratory has been asked by Dominion and Colonial Governments to investigate some seventy different kinds of insect and weed pests in the hopes that parasites might be found.

It is estimated that blowflies annually destroy about 5 per cent. of the sheep of Queensland, and cost Australia £4,000,000 a year. The wheat stem sawfly did £2,500,000 worth of damage in 1926 in one province alone. America suffers so severely that a sum of £2,000,000 was recently spent by the government in one year in an effort to check the advance of a single insect, the European corn borer. This borer is now advancing into Canada. The United States has recently spent £12,000,000 in fighting five insects.

The report describes some curious devices invented by entomologists. One of these is called a "bouncing machine." Insect eggs are made to roll down a wooden chute and bounce off a small piece of tin at the bottom. An egg which has been parasitized—that is, which has another egg, laid by the parasite, inside it—has not the same capacity for bouncing as have

healthy eggs, which jump into a further tin, and so are separated for laboratory purposes.

Shipments of some twenty different kinds of insects have been sent overseas, generally in cold storage, in special cases with food, such as raisins or sugar and water, for rations. Fourteen consignments of a parasite which attacks woolly aphis—a serious apple-tree pest—have been distributed in England, India and Kenya Colony. This has practically exterminated woolly aphis in New Zealand. Parasites of the wheat stem sawfly, the whitefly and the pine shoot moth have gone to Canada; one which attacks the sheep blowfly has been shipped in large quantities to Australia and South Africa; a Californian ladybird has gone to Madras; a miniature wasp which eats the pear slug has gone to New Zealand and a bollworm to the Barbados. In all, a total of about 58 shipments, comprising some 100,000 specimens, have been shipped from the laboratory to various parts of the Empire.

THE IRON ALLOYS COMMITTEE OF THE ENGINEERING FOUNDATION

A SUMMARY of world progress in the field of iron alloys, advance in which is held to be fundamental for American industry, is the object of a program of research enlisting the cooperation of more than sixty industrial and scientific organizations and corporations of the United States under the leadership of the Engineering Foundation.

A fund of $230,000 to make possible a review of all available literature has been contributed by the cooperating organizations, among which are the American Foundrymen's Association, the Battelle Memorial Institute of Columbus, Ohio, and approximately fifty companies producing or using steel and iron. Universities and technical schools, foreign agencies and bureaus of the United States Government are aiding the project, in which the Engineering Foundation has the active assistance of the American Institute of Mining and Metallurgical Engineers and the American Iron and Steel Institute. The American Society of Mechanical Engineers, American Society of Civil Engineers and American Institute of Electrical Engineers also are cooperating.

The scope of the investigation, which is described as the most ambitious ever undertaken in this field, was outlined by an advisory committee headed by Dr. John Johnston, director of research and technology of the United States Steel Corporation. Supervision of the program, which will require five years for completion, has been delegated to an Iron Alloys Committee, of which Dr. George B. Waterhouse, professor of metallurgy in the Massachusetts Institute of Technology, is chairman.

As its initial task, the foundation and its cooperating organizations are conducting a critical review of all available literature in English and other languages. Coincident with this review, two lines of original research into iron alloys have been initiated. Others will be taken up later as the need for them is revealed by the critical examination of the very extensive literature.

Underlying the plans of the foundation and its associated bodies is the growing necessity for condensed, dependable statements in convenient, classified reference books, of the basic information upon which the future advancement of the iron and steel industry may be built. World competition and increasing demands upon production are expanding the need for research which will keep the United States abreast of progress in the field of iron and steel alloys.

The critical examination of scientific and trade journals and books published during the last forty years in all parts of the world is the first step being taken by the committee. Much progress has been accomplished. A list has been made of approximately 2,000 journals in ten languages, containing information of all kinds on iron and its combinations with other substances, the announcement says. This list is believed to be very nearly complete for all periodicals which have been published for any period since 1890 in twenty-five countries. Books will also be included in the review.

The portion of the enterprise now in hand is searching the literature for information on thirty-nine elements and compounds in twenty-three separate classifications, making a total of more than 800 classifications.

With the cooperation of Lehigh University, a study of the combinations of iron with silicon was begun under the direction of Mr. Bradley Stoughton, professor of metallurgy, who brought to the Engineering Foundation the suggestion that has been expanded into the Alloys of Iron Research. The review of the literature has been nearly completed, a bibliography prepared, some laboratory research done and a monograph drafted.

A grant was made to the Carnegie Institute of Technology to assist a research in the combination of iron with manganese by V. N. Krivibok, associate professor of metallurgy, and associates under the direction of Francis M. Walters, Jr., director of the Bureau of Metallurgical Research. Important results have been achieved in the laboratory, and progress has been made upon a review of the literature. These two projects have proved fruitful not only in information on their subjects, but also in guidance to the committee in devising methods for the whole enterprise.

Through a form designed to expedite abstracting, all the information gathered on each one of hundreds of subjects can be readily assembled. As the review of literature progresses there is being built up a valuable body of reference material on which may be based later a service of great convenience to persons preparing programs for research, patent claims, papers for technical societies and for other purposes. More than 3,000 abstracts have already been made and filed.

The Engineering Foundation has the cordial cooperation of the American Institute of Mining and Metallurgical Engineers and other societies of engineers; the American Iron and Steel Institute, American Foundrymen's Association, Battelle Memorial Institute, Columbus, Ohio; Carnegie Institute of Technology, Pittsburgh; Lehigh University and other universities, iron and steel companies and other industries, the National Bureau of Standards, United States Bureau of Mines, technical journals and numerous individuals. Informal assurances of foreign cooperation also have been received.

Such laboratory research as the committee undertakes will have for its aim the production of basic data which may be freely disseminated. Utilization of the data for commercial processes will be open to the industries.

DEDICATION OF THE JAMES WARD PACKARD LABORATORY AT LEHIGH UNIVERSITY

THE James Ward Packard Laboratory for Electrical and Mechanical Engineering was dedicated at Lehigh University on October 15. Mr. Charles M. Schwab, chairman of the board of trustees of the Bethlehem Steel Corporation and a trustee of the university, who made the dedicatory address, paid high tribute to the late Mr. Packard, donor of the building. Dr. Charles Russ Richards, president of the university, was chairman. The architects, Messrs. T. C. Visscher and J. L. Burley, of New York City, were introduced and the former presented the keys of the building to Mr. Eugene G. Grace, president of Lehigh's board of trustees. The keys were then presented in turn to Dr. Richards, Professor F. V. Larkin, head of the department of mechanical engineering, and Professor S. S. Seyfert, acting head of the department of electrical engineering.

A two-day conference on the relations of technical schools to industry followed the dedication, at which the subjects and speakers were as follows: "What Industry Expects of the Technical Schools": F. A. Merrick, president Westinghouse Electric and Manufacturing Company; L. W. Baldwin, president Missouri Pacific Railway; A. R. Glancy, president Oakland Motor Car Company; M. S. Sloan, president Brooklyn Edison Company; Bancroft Gherardi, vice-president and chief engineer American Telephone and Telegraph Company.

"What the Technical Schools Expect of Industry": Dr. Arthur Maurice Greene, Jr., dean of the School of Engineering, Princeton; Professor Dugald Caleb Jackson, head of the department of electrical engineering at Massachusetts Institute of Technology; David Ross, president of the Ross Gear Company and president of the board of Purdue University, and Dr. William E. Wickenden, president of the Case School of Applied Science.

"The Future of Industry, its Problems and Needs": Magnus W. Alexander, president National Industrial Conference Board, New York City; "Distribution and Its Effect on Industry," Edward A. Filene, president and chairman of the board of William Filene's Sons' Company, Boston; "The Effects of Research on the Future of Industry," Dr. John Johnston, director of research, United States Steel Corporation, Kearny, New Jersey, and "The Methods of Industrial and Business Forecasting," S. L. Andrew, chief statistician, American Telephone and Telegraph Company, New York.

THE FRANKLIN INSTITUTE

DR. HOWARD MCCLENAHAN, secretary of the Franklin Institute and director of the Benjamin Franklin Memorial and Franklin Institute Museum, announces that three heads of departments of the museum have been appointed. Dr. James Barnes, present professor of physics in Bryn Mawr College, has been appointed head physicist and will assume the duties of his office at the completion of his present year in Bryn Mawr. Mr. Charles E. Bonine, of the firm of consulting engineers Bonine and Costa, will serve as head of the engineering section of the scientific staff. Mr. Bonine has already taken up active work in connection with the development of engineering in the new museum. Mr. James Stokley, of Washington, D. C., a member of the staff of Science Service, will be the head of the astronomical section of the new institution. Mr. Stokley will be responsible for the operations of the planetarium section and of the astronomical observatory, as well as the outdoor observatory of the museum. These three men, together with Dr. McClenahan who is himself an electrical engineer by training and has been for some twenty-eight years a professor of physics in Princeton University, form the nucleus for the staff of the new institute. A director of the chemical section will

soon be added. Other members of the staff will be appointed as the development of the exhibits proceeds and the need for other services becomes evident.

Lectures before the Franklin Institute are announced as follows:

October 15—Dr. and Mrs. Paul H. Dike, Philadelphia, Pa. "Theremin: Theory and Practice." Dr. Dike will develop the theory of this instrument and Mrs. Dike, who is a licensed performer, will demonstrate the use of it and will give a recital upon it.

October 23—Clifford B. White, M.E., American-LaFrance and Foamite Industries, Inc., Elmira, N. Y. "Modern Fire Extinguishing Methods."

October 30—Douglas Stanley, M.S., New York City. "The Science of Voice." W. M. Jennings, Esq., Philadelphia, Pa. Display of "A New Photography."

November 6—H. H. Lester, Ph.D., research physicist, Watertown Arsenal. "The Use of X-rays in Industry."

November 13—Arthur E. Morgan, D.Sc., president of Antioch College. "The Nation's Water."

November 19—R. T. Haslam, B.S. in Eng., Standard Oil Development Company, New York City. "The Hydrogenation Process in Petroleum Refining."

December 4—J. B. Johnson, Ph.D., research physicist, Bell Telephone Laboratories, Inc., New York City. "The Cathode Ray Oscillograph."

December 10—Sir Henry W. Thornton, K.B.E., chairman of the boards of directors and president, Canadian National Railways. "Men and Industry."

December 17—Saul Dushman, Ph.D., assistant director, Research Laboratory, General Electric Company, Schenectady, New York. "Methods for the Production of High Vacua."

SCIENTIFIC NOTES AND NEWS

THE Capper Medal of the National Country Life Association of $5,000 was presented to Dr. Stephen Moulton Babcock on the evening of October 10. The money and a plaque were given to him by the donor, Senator Arthur Capper, Kansas publisher, and the story of his work was recounted by Mr. Frank O. Lowden, former governor of Illinois and president of the association. Dr. Babcock, who celebrated his eighty-seventh birthday on October 22, became professor of agricultural chemistry at the University of Wisconsin in 1888 and retired as professor emeritus in 1913.

THE honorary doctorate of laws was conferred at the opening session of the annual convocation of the University of the State of New York on Dr. William H. Welch, of the Johns Hopkins University. In conferring the degree Dr. Frank Pierrepont Graves, president of the university, recalled that Dr. Welch is a graduate of the medical school of Columbia University and carried on his first activities as instructor at Bellevue College of New York University. Continuing he said: "The years that bridge the interval between that first professorship and your present world-wide eminence as teacher, investigator, administrator and leader among scientists are filled with accomplishments and crowded with well-earned honors. No man has done more to make available to America the blessings of modern scientific medicine and public health work."

THE degree of doctor of laws was conferred on Dr. William J. Mayo, of Rochester, Minnesota, at the recent dedication of the medical school building of Temple University.

DR. E. P. FELT, for thirty years state entomologist at the New York State Museum at Albany previous to his retirement from the state service, has been made collaborator of the museum, in recognition of his scientific work and his cooperation with the museum. The two others previously so honored are Dr. A. P. Brigham, of Colgate University, and Professor George H. Hudson, formerly of the State Normal School, Plattsburgh, N. Y.

DR. ERNEST S. LEWIS, emeritus professor of obstetrics and gynecology at the College of Medicine of Tulane University, was on September 24 the guest of honor at a luncheon given by medical colleagues celebrating his ninetieth birthday. Dr. Lewis has been connected with Tulane University for sixty years. The speaker was Dr. Rudolph Matas.

FOUR foreign surgeons were awarded honorary fellowships in the American College of Surgeons at the convocation on October 17, which concluded the twentieth clinical congress of the college. These were Professor Henry Wade, of Edinburgh, surgeon and urologist; Professor Otfried Foerster, Breslau, neurologist; William Ernest Miles, London, and Professor Dr. Emil von Grósz, Budapest, ophthalmologist.

DR. ALLEN B. KANAVEL, professor of surgery at Northwestern University, was elected president of the American College of Surgeons at the twentieth annual meeting held in Philadelphia. Dr. Rose Millar, Ottawa, and Dr. Eldridge J. Eliason, Philadelphia, were elected vice-presidents.

PROFESSOR WILLIAM R. RANSOM, of Tufts College, was elected president of the Bond Astronomical Club at the first meeting of the season at the Harvard Observatory.

PROFESSOR EGAS MONIZ on October 15 was elected

president of the International Congress of Hydrology, Climatology and Geology at Lisbon.

DR. STORRS B. BARRETT, associate professor of astrophysics, who has served as secretary and librarian of the Yerkes Observatory for the past thirty years, retired on September first under the regulations of the University of Chicago. He will continue to reside at his home adjacent to the grounds of the observatory. He was succeeded on the same date by Dr. Clifford C. Crump, formerly professor of astronomy at Ohio Wesleyan and director of the Perkins Observatory and more recently professor and chairman of the department of astronomy at the University of Minnesota.

DR. JOHN RATHBONE OLIVER, for fifteen years chief medical officer of the supreme bench of Baltimore, has resigned to accept an assistant professorship of the history of medicine at the Johns Hopkins University School of Medicine.

DR. ROGER D. BAKER, who has been during the past year assistant resident pathologist at the Johns Hopkins Hospital, has been appointed instructor in anatomy at Duke University.

AMONG recent additions to the Colgate University faculty are Mr. John A. Allen, from the University of Minnesota, who has been appointed first instructor in astronomy and who will have charge of survey work in that subject; Mr. H. M. Lake, of the University of Texas, instructor in psychology, and Mr. James Stauffer, instructor in biology.

DR. HANS F. K. GÜNTHER, known for his books on races in Europe, has been promoted to be professor of eugenics at the University of Jena.

DR. CHARLES J. STUCKY, formerly research chemist at the research laboratories of Scott and Bowne, Bloomfield, New Jersey, is now research assistant in chemistry at the New York State Psychiatric Institute and Hospital, New York City.

DR. HAROLD LEVINE, formerly chief chemist of the research laboratories of Scott and Bowne, is now research associate at the South Carolina Food Research Laboratory at Charleston, S. C., where he is in charge of nutritional investigations on animals.

DR. ERWIN W. TSCHUDI has entered the Point Breeze Works of the Western Electric Company at Baltimore as physicist-engineer.

DR. F. E. CHIDESTER, of the department of zoology, of West Virginia University, has received a grant of $500 from the National Research Council to continue his work on nutrition. This is the second grant that he has received from the council for this purpose.

ON the recommendation of its advisory council, the British Department of Scientific and Industrial Research has decided to make a senior research award for a period of three years, and of the value of £300–£350, to Mr. E. A. Stewardson, of the department of physics in the University of Liverpool.

DR. THEOBALD SMITH, of the Rockefeller Institute for Medical Research, Princeton, New Jersey, delivered the William Henry Welch Lectures under the auspices of the trustees and medical staff of the Mount Sinai Hospital, New York City, on October 17 and 18. The subjects of the lectures were: "The General Problem of Respiratory Diseases as Illumined by Comparative Data" and "A Comparative Study of Spontaneous and Induced Streptococcus Disease in the Same Species."

DR. HARLAN T. STETSON, director of the Perkins Observatory, will lecture on "Sun Spots and Radio Reception" at the meeting of the Pittsfield section of the American Institute of Electrical Engineers, on November 4.

THE Medical History Club of the College of Medicine of the University of Illinois opened its fourth season on October 15 with a lecture by Dr. W. F. Petersen on "Count Struensee." These public lectures are held in the Library of the College of Medicine on the first and third Wednesdays of each month at 1:00 P. M.

DR. GRAFTON ELLIOT SMITH, professor of anatomy in the University of London, will give two lectures at the University of California on November 18 and 19 on "Peking Men" and "The Evolution of the Human Brain."

ANNOUNCEMENT has already been made of the names of those who have accepted appointment to the George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University for the next two years. They are: First term, 1930–31, Professor G. Hevesy, University of Freiburg, Germany; Second term, 1930–31, Dr. N. V. Sidgwick, Lincoln College, Oxford, England. First term, 1931–32, Professor W. L. Bragg, University of Manchester, England; Second term, 1931–32, Professor Alfred Stock, Technische Hochschule, Karlsruhe, Germany. To this list may now be added: First term, 1932–33, Professor Cecil H. Desch, Sheffield, England; Second term, 1932–33, Professor Otto Hahn, Kaiser Wilhelm Institut für Chemie, Berlin-Dahlem, Germany; First term, 1933–34, Professor V. M. Goldschmidt, Göttingen, Germany; Second term, 1933–34, Professor Robert Robinson, Oxford, England.

THE American Astronomical Society has formed a

committee of twenty to proceed with the necessary organization for the meeting of the International Astronomical Union which is to be held in this country in 1932. An executive committee consisting of E. W. Brown, W. W. Campbell, R. S. Dugan, Frank Schlesinger, Harlow Shapley, Joel Stebbins and H. N. Russell has been selected, and several subcommittees appointed. The meeting will be held in Cambridge, Massachusetts, beginning as soon as practicable after the total eclipse of the sun on August 31.

THE Botanical Society of New Orleans was organized on October 9 with the following members as a nucleus: Professor William T. Penfound, Mrs. William T. Penfound, Mr. M. E. O'Neill, of the College of Arts and Sciences of Tulane University; Dr. Miriam L. Bomhard, Miss Anna Haas, of Newcomb College of Tulane University; Mr. E. L. Demmon, Dr. L. J. Pessin, Mr. Philip C. Wakely, Mr. W. G. Wahlenberg, Mr. P. V. Siggers, Mr. R. M. Lindgren, Mr. G. H. Lentz, Mr. J. D. Sinclair, Mr. Robert Winters, Mr. Henry Bull, Mr. H. G. Meginnis, of the Southern Forest Experiment Station; Mr. George Thomas, head of the New Orleans Parking Commission, and Mr. James McArthur, director of nature study in the Orleans Parish Public Schools. The organization proposes to interest itself chiefly in the taxonomy and ecology of the Gulf States, discussing particularly certain general phases of ecology from the standpoint of their local application. Professor Penfound is president and Dr. Bomhard is secretary-treasurer of the society.

Industrial and Engineering Chemistry writes: "An organization of Yale chemists and chemical engineers, to be known as the Yale Chemical Association, was formed on September 27, at New Haven. Some sixty men and women met at 'Bethwood,' the beautiful country home of Professor Treat B. Johnson, for a picnic luncheon and reunion. The guest of honor was Professor Emeritus W. G. Mixter, now in his eighty-fourth year, who is known and loved by several generations of Yale men. After the luncheon a brief meeting was held, at which Dean W. T. Read, of Rutgers, presided. Informal talks were made by Professor Johnson, Dean C. H. Warren, of the Sheffield Scientific School; A. J. Hill, chairman of the department of chemistry, and C. O. Johns. A nominating committee composed of H. W. Foote, C. R. Downs and E. M. Shelton presented a report which resulted in the election of the following officers: *President,* C. O. Johns; *vice-president,* E. B. Hurlburt; *secretary-treasurer,* J. J. Donleavy.

ACCORDING to the *Journal* of the American Medical Association graduate courses for surgeons and radiologists, held four times a year at the Johns Hopkins Hospital, were announced at the recent three-day graduate teaching course on "The Diagnosis and Treatment of Bone Tumors," held under the auspices of the Garvan Research Laboratories and the Copley Surgical Pathological Laboratory of the Johns Hopkins University, under the direction of Dr. Joseph Colt Bloodgood. The attendance comprised 363 physicians from 42 states. The plan is to supplement the new courses by correspondence and a system of diagnosis in which roentgen plates are sent in by nonresident radiologists. Another development announced in the war on cancer is the creation of a corporation to advance the science of radiology as it bears on the diagnosis and treatment of cancer. This corporation—the Radiological Research Institute—will finance research workers and fellowships in universities and is made possible by gifts from the Chemical Foundation and its president, Francis P. Garvan. The graduate course given at Johns Hopkins will be repeated before the meeting of the Radiological Society of North America in Los Angeles, December 1–5; the admission is free, but attendance is limited to 800.

DISCUSSION

THE FORMATION OF STRIAE IN A KUNDT'S TUBE

SOME experimental work has been carried on by the author from time to time on the formation of striae in a Kundt's tube. Since the summer of 1924 observations seemed to show a rotation of the dust particles on each side of the striae, and in July, 1929, the author succeeded in showing that such rotation does take place.

A glass tube about 150 cm long and about 2 cm inside diameter had some burned cork scrapings scattered along its inside. A sheet tin piston connected to one prong of an electrically driven tuning-fork was used to excite the air vibrations in the tube. The piston was inserted a short distance into the end of the tube and the other end of the tube was closed with a tight-fitting cork. When the fork was made to vibrate complete disks of cork dust were produced across the tube at the antinodes, and close observation showed that at each disk two distinct orbits of rotating particles were present, one on each side of a single striation, one clockwise, and on the opposite side a counterclockwise rotation. The rotations take place so that the particles leave the top of the stria-

tion and enter at the bottom of the same striation. Midway between two adjacent striae little striae lower than the others tend to form but are soon destroyed by the rotations mentioned above, the dust particles forming these lower striae being pulled away in opposite directions and forced into the two adjacent striae at the bottoms of the same. Thus the dust particles are pulled away from a line approximately midway between adjacent striae in opposite directions and forced into the major striae at their bottoms. When the agitation of the dust particles is violent the striae at the antinodes, especially those extending completely across the tube as disks, do not remain always in one position but very often merge into each other. When the agitation is less violent, as in the case where the striae do not extend completely across the diameter of the tube from top to bottom, there seem to be two orbits of rotation on each side of a striation, one above the other, rotating in opposite directions so that the direction of rotation is from near the middle of the striation, one orbit entering the top of the striation and the other orbit entering the bottom of the striation, somewhat as two meshed cogs, one directly above the other, would rotate.

While there seems to be experimental evidence in the scientific literature for the support of the explanation of the formation of striae in a Kundt's tube as given by Koenig,[1] the author is inclined to believe that the formation of these striae may be satisfactorily explained in a manner similar to the explanation for the formation of ripple-mark in sand as given by Darwin.[2]

In the summer of 1927 the author was able to maintain two paper segments (cut in a shape similar to a dust striation) upright in the tube. When pith dust also was present a violent somewhat elliptically shaped rotation, about an inch long along its major axis parallel to the axis of the tube, was produced. Also a single segment of paper similar to a dust striation has been maintained upright in the tube for a short time by means of the air vibrations.

In the summer of 1927 striae were obtained by the author by allowing puffs of air, produced by interrupting a continuous air stream from a small glass nozzle by a rotating siren disk, to enter a glass tube, one end of which was corked and in which pith dust was distributed along the bottom. These striae were formed when the air jet was interrupted too slowly to produce an audible tone.

The author is continuing his investigation of these striae photographically and is making an effort to determine the effects produced by forming them in various gases, in tubes of various diameters and lengths, and by sources of various frequencies.

Rolla V. Cook

Bethany College

[1] *Wied. Ann.*, 42: 353, 549, 1891.

[2] *Proc. Royal Soc.*, 36: 18, October 18, 1883.

A HYPOTHESIS ON THE CAUSATION OF CANCER[1]

According to genetics, all variations in species are due either to mutations of the chromosomes or to recombinations of chromosomes in which mutations have previously occurred. If this mutation occurs in a germ cell, it will result in a hereditary characteristic that will persist until the line is extinct or until a new mutation intervenes, but if this mutation occurs in any other cell of the body except a germ cell, it will persist only as long as the particular individual lives, and will become extinct with the death of this individual, unless the tissue of mutated type cells is transplanted to some other sustaining medium. (All cells other than germ cells are called somatic cells.) This latter type of mutation is called "somatic" mutation. Such mutation may be lethal or beneficial.

> *Cancer* is generally regarded as a localized lawless and unrestrained growth of epithelium, the cells (somatic) having become parasitic cells, and attacked the host. The only cure thus far discovered is an early destruction or removal of the abnormal parasitic cells.
> The causation of cancer apparently lies in the disturbed balance of the forces of stimulating and restraining growth in the affected cells, and is probably essentially a faulty cellular chemistry.[2]

Unequal distribution of chromosomes in somatic cells may result in abnormal tissue and also a change in the physicochemical components of one or more genes in those cells.

This hypothesis then considers cancer as due primarily to mutation in a somatic cell. That the mutation is *lethal* is borne out by its subsequent course. Its ultimate result is death of the individual, the mutation being of a somatic cell and not of a germ cell. Whether cancer is a heritable factor or not has never been clearly shown, but it is entirely possible that the *lack of resistance* to the same type of mutation reappearing in subsequent generations of the same line could be passed on as an inherited characteristic, as shown by the well-known frequency of cancer as a hereditary taint in such lines.

Therefore, the theory of a bacterial causation of

[1] The authors are deeply indebted to Dr. Herbert Fox, director of the Pepper Laboratory at the University of Pennsylvania, and to Professor W. R. Coe, professor of genetics and biology at Yale University, for their interest, advice and encouragement in the publication of this paper.

[2] Ferris, "Evolution of Earth and Man," p. 213.

cancer seems to be unnecessary, since it can be explained by a physicochemical fault, and if bacteria are found it is probably accidental.

Boveri[3] (1902) suggested that irregular somatic mitosis might well account for the peculiar behavior of these peculiar cells. He did not include other mutations, however.

Cancer cells show abnormal metaplasia. Instead of "flattening out" like normal epithelial cells they remain "swollen up." There is also a shift of the nucleus towards the center. They become parasitic and live at the expense of their sister cells.

Now something has happened in such cells to change their normal metaplasia. Bacteria have been held as the causative factor in this "change of stream," but this conviction is growing less and less. *True sarcoma,* however, has been found around tape-worms (Francis C. Wood) and other intestinal worms (Philadelphia Zoo Laboratory). Another factor often advanced has been a genetic factor where cancer is regarded as a true Mendelian recessive.

This hypothesis, it might be argued, would stand or fall on whether the Mendelian law is applicable to cancer families.

However, this hypothesis holds that it is a mutation of a *somatic* cell and not of a *germ* cell, that the mutation itself dies with the individual and is not transmitted directly, that the normal resistance to such imbalance may be weakened and this lowered resistance may be transmitted as a dominant or recessive characteristic or as a multiple factor. This factor would be subject to Mendelian laws.

Note: It is a well-known fact, genetically, that mutations experimentally can be speeded up tremendously by exposure to stimulating amounts of radiation and the X-ray effect, where greater doses are destructive. Perhaps the frequently observed "skin-cancers" in Roentgenologists are due to such mutations occurring from *stimulating* exposure to the X-ray effect (the release of the cathode ray).

Would it be possible that some such agency is active in the greatly increased prevalence of cancer? Of course, it is understood that other factors are concerned both in its relative and actual increase.

Evolutionary variations in species, due to mutations in the germ cells, have been very irregular in their intensity. There have been periods of extreme activity in this field, gradually shading down to a comparatively quiescent state. It is held by some that these periods of great evolutionary expansion have coincided with the great crustal revolutions of the earth, and that they may have been due to the influence of emanations from the radioactive ores that were released in these upheavals.

It is possible that in this intensive electrical age there may be radioactivity and rays that are beyond our present knowledge, which might be sufficient to stimulate mutations in the chromosomes of somatic cells. Again this same electrical influence might be of cosmic origin.

Babcock and Collins[4] performed an experiment with *Drosophila* comparing the rates of occurrence of sex-linked lethal mutations in a street-car tunnel in San Francisco and in their laboratory. A location was discovered in the tunnel where the natural ionization radiation was fully twice as great as the radiation in their laboratory in Berkeley. The difference in rate was 2.5 times the probable error for the flies which had been exposed in the tunnel. In other words, the rate of lethal sex-linked mutation was more than doubled when the flies were transferred to a more highly *ionized* location.

Hanson and Heys[5] performed independently similar experiments in a carnotite mine in Colorado where the air was strongly ionized. Their results check closely with those of Babcock and Collins.

While these two experiments fall short of being statistically significant, it is clearly shown that ionization plays an important part in the rate of mutation of the germ cells. It would not be too fanciful to assume that such ionization would also affect the rate of mutation of the somatic cells as well.

We admit that such a suggestion would be hard to determine by research, but study of the effects of X-ray radiations of a less intensity than necessary to inhibit all reproductive activity in cells might be of value.

ROBERT S. MCCOMBS
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THE MAGNETIC POLES OF THE EARTH AND THE BIRTH OF THE MOON

DR. OLIVER JUSTIN LEE's article on "The Magnetic Poles of the Earth and the Birth of the Moon" in SCIENCE of July 25 interests me greatly.

A number of years ago I was impressed with the same fact, namely, that the magnetic poles are not on the axis of the earth, which would seem to be the logical place for them, nor are they even antipodal to each other. When I found that the shortest distance between them was across the center of the Pacific I immediately began to wonder if the removal

[3] Republished, "Origin of Malignant Tumors," Williams and Wilkins Company, Baltimore, 1929.

[4] E. B. Babcock and J. L. Collins, "Natural Ionizing Radiation and the Rate of Mutation," *Nature,* 124: 227–228, 1929.

[5] F. B. Hanson and Florence Heys, "A Possible Relation between Natural (Earth) Radiation and Gene Mutation," SCIENCE, 71: 43–44, 1930.

of the moon mass from the area which is now the Pacific was responsible for this peculiar fact.

In 1926 I had a number of mimeographed copies made of a short article on "The Origin of the Moon" which consisted of about 14 ordinary letter size sheets of typewritten material.

By 1927 I became impressed more with the earthly effects and had a twenty-six page booklet printed giving a large number of facts which seemed to me to support the theory that the removal of a large mass of crustal material, from what is now part of the Pacific Ocean, caused the shifting of the axis of rotation of the earth, caused the magnetic poles to become closer to each other on the Pacific side of the globe and created the major outlines of the continents. The title of this booklet is "The Formation of the Continents and Oceans as We Know Them."

In the September, 1928, issue of the *Pan-American Geologist* an article of mine on "Symmetric Disposition of Tertic Mountain Systems" was published. This calls attention to a very remarkable symmetry which is created when, on a globe, the magnetic poles, together with underlying continents, are placed back in their assumed original positions.

In the March, 1929, issue of the same journal another article of mine on "Continental Drifting in Northwestern Europe" was published. This article was not confined to a statement of the one bit of contributory evidence which the title indicates, but covers briefly some of the major features of my theory and the evidence supporting it.

In the May, 1930, issue of the same journal an article which I contributed on "Bilateral Symmetry of Earth's Largest Continental Block," with an illustration, described a symmetry of Europe, Asia and Africa around a great circle passing through the south magnetic pole, which I attribute to the removal of a large mass from part of the Pacific, which mass may now be our moon.

Before the Geological Section of the American Association for the Advancement of Science, at their Des Moines meeting last winter, I read a paper, with lantern illustrations, setting forth my theory and the facts on which it was built as well as a small part of the supporting evidence.

I have seen no other mention of this peculiar relationship that seems to exist between the magnetic elements of the earth and the major features of the earth.

Some of the conclusions which the evidence in the case has forced me to are almost revolutionary.

My theory, in a very peculiar manner, seems to fit in, to a certain degree, with Wegener's theory of continental drift of the Americas, so I submitted my theory to W. A. J. M. van Waterschoot van der Gracht, who recently conducted a symposium on the theory of continental drift. Of my theory and the facts which I advance in support of it he recently wrote me as follows:

> These curious magnetic facts must have *some* explanation, and they may be very important for further speculation as to the internal constitution of the earth, and also for the changes in its facial expression. . . . I think that your work brings some very interesting new facts and arguments into the discussion of this most involved problem. . . . Your discussion of the magnetic situation is very interesting and certainly deserves further work and thought.

D. W. Longfellow

Elk River, Minnesota

THE CONCEPTION OF BALANCE WITH RESPECT TO THE ABSORPTION OF NITROGEN, PHOSPHORUS AND POTASSIUM BY PLANTS AND THE INFLUENCE OF THE LEVEL OF NUTRITION

In a recent paper, the writer[1] called attention to the remarkable and consistent results obtained over a 10-year period by Lagatu and Maume[2] from a series of field experiments conducted with the grape (*Vitis vinifera*). These authorities concluded that the depression in yields produced by the application of an "incomplete" fertilizer, *i.e.*, one containing only two of the principal fertilizer constituents, nitrogen, phosphorus, potassium, is not due to a *depression* of the absorption of the remaining elements, but, on the contrary, to a nutritional lack of balance owing to an *increased* absorption of these elements.

Field experiments have also been reported[3] in which it was noted that the omission of potassium from a fertilizer applied to a soil deficient in this element resulted in an *increased* absorption by the plants of the nitrogen and phosphorus present in the "incomplete" fertilizer. But in these experiments of Wallace it is to be noted that the omission of nitrogen from the fertilizer resulted in a *decreased* absorption of phosphorus and potassium, and the omission of phosphorus in a *decreased* absorption of nitrogen and potassium.

In the course of experiments[4] with *Pyrus malus* L. grown under controlled conditions, the writer has had a unique opportunity of examining the principles

[1] Walter Thomas, Science, 70: 382–384, 1929.

[2] H. Lagatu, *Compt. Rend.*, 172: 129, 1921; H. Lagatu and L. Maume, *Compt. Rend.*, 179: 782, 1924; *ibid.*, 179: 932, 1924; *ibid.*, 180: 1179, 1925; "Communication au Congrès des engrais azotés de synthèse à Montpellier," Juin 1, 1927, pp. 1–15.

[3] T. Wallace, *Jour. Pomol. and Hort. Sci.*, 7: 130–145, 1928.

[4] Walter Thomas and R. D. Anthony, *Proc. Am. Soc. Hort. Sci.*, 81–87, 1926; Walter Thomas, *Plant Physiology*, 2: 109–137, 1927.

enunciated by Lagatu and Maume. It has been found in our experiments that the course of absorption of nitrogen, phosphorus and potassium from fertilizer mixtures containing only two of them is in accordance with the deductions made by Liebig.[1] Thus, a comparison of the absorption graphs of trees receiving additions of two only of the elements, nitrogen, phosphorus, potassium, with the absorption graphs of trees which received additions of all these elements indicates a depression of the absorption of the elements from the "incomplete" or unbalanced fertilizer.

Since, therefore, generalization of Lagatu and Maume's principles is not permissible, it is pertinent to seek an explanation of the causes operative. The discrepancy between the results of the experiments under discussion may not be attributed to differences in the ratios, amounts or composition of the fertilizers applied, for these are very similar. The conception of physiological balance resulting from Loeb's[5] pioneer experiments and its further expansion by McCool,[6] Osterhout[7] and others have stimulated a vast amount of investigation by plant and animal physiologists and, although quantitative experiments[8] with plants have been made to ascertain the factors influencing the selective absorption (diffusion) into the cell of one salt (or ion) by another present in the nutrient solution, the discovery of a general law applicable under all conditions has not been forthcoming. It is, however, apparent from such experiments that there exists for each species a physiologically balanced nutrient solution—which may in actual field practice be determined by the method of Mitscherlich[9]—from which normal permeability occurs; and that a departure from this balance will produce a disturbance in the rate of absorption relations of the various ions that may have a profound effect on metabolism.[7] Normal permeability has been explained[10] on the basis of antagonistic salt action; but the extent to which salt (or ion) antagonism is responsible for the maintenance of normal permeability of plants grown under field conditions is problematical. In the field experiments here cited the results do not appear to be applicable on the basis of simple antagonism—at least in the sense defined by Loeb[10] and as discussed more recently by Loehwing[11]—for plants grown on these soils containing normal concentrations of calcium ions absorbed more (not less) potassium from a fertilizer containing only nitrogen and phosphorus. There is evidence,[7] moreover, to show that antagonism becomes weaker and weaker as the concentration decreases. Thus, Osterhout found that although 0.05 M $NaCl$ + 0.06 M $CaCl_2$ exerted a marked toxic effect on root growth, 0.001 M + 0.0012 M solutions, respectively, of this mixture had no antagonistic effect. We should expect, therefore, little or no antagonistic effect in solutions of such low concentration as that of the soil solution. For example, the concentration of salts in the soil in the present experiments varied from 350 to 640 p.p.m. according to the season. In all nutrient culture experiments with seedling plants in which the phenomenon of antagonism has been observed, the concentration of salts present is from five to twenty times that of the salts in the soil solution from normal soils.

However, although ion antagonism may be of negligible consequence in solutions as dilute as the soil solution, experimental evidence exists to show that the concentration of nutrients (level of nutrition,[9, 12] *i.e.*, rate of supply of nutrients[13] or supplying power[14]) of the soil solution may be the factor of greatest influence in determining the course of absorption. Thus, from Remy's[15] numerous field experiments it is apparent that the addition of any two of the elements, nitrogen, phosphorus, potassium, to soils relatively deficient in these elements, such as the Hagerstown clay loam soil used in the experiments of the writer, results in a *decrease* in the absorption of the remaining element in accordance with the deductions of Liebig.[1] This decreased absorption does not occur on soils—such as that used by Lagatu and Maume[2]—well supplied with these elements, but always an increased absorption.[15, 16] In this connection it is of interest to note that Waynick[17] observed

[5] Jacques Loeb, "Opperheimer's Handbuch der Biochemie des Menschen und der Tiere," Zweiter Bd., Teil I, Gustav Fischer, Jena, 1909.

[6] M. M. McCool, Cornell Univ. Agr. Exp. Sta. Memoir No. 2, 119–216, 1913.

[7] W. J. V. Osterhout, "Injury, Recovery and Death in Relation to Conductivity and Permeability," J. B. Lippincott Company, Philadelphia, 1922.

[8] D. D. Waynick, *Univ. Calif. Pub. Agr. Sci.*, 3: 135–242, 1918; D. R. Hoagland and J. C. Martin, Univ. Calif. Pub. Agr. Exp. Sta., Tech. Paper No. 8: 1–26, 1923; H. S. Reed and A. R. C. Haas, *Jour. Agr. Res.*, 24: 801–814, 1923; Univ. Calif. Pub. Agr. Exp. Sta., Tech. Paper No. 11: 1–23, 1923; Univ. Calif. Pub. Agr. Exp. Sta., Tech. Paper No. 17: 1–75, 1924; D. R. Hoagland and A. R. Davis, *New Phytologist*, 24: 99–111, 1925; E. Pantanelli, *Protoplasma*, 7: 129–137, 1929.

[9] A. Mitscherlich, "Die Bestimmung des Düngerbedürfnisses des Bodens," Paul Parey, Berlin, 1925.

[10] Jacques Loeb, "Dynamics of Living Matter," Columbia University Press, New York, 1906; *Biochem. Ztschr.*, 32: 308–322, 1911; SCIENCE, 36: 637–639, 1912.

[11] Walter F. Loehwing, *Plant Physiology*, 3: 261–275, 1928.

[12] H. P. Cooper, *Plant Physiology*, 5: 193–214, 1930.

[13] D. R. Hoagland, *Jour. Agr. Res.*, 18: 73–117, 1919.

[14] Burton E. Livingston, Proc. Intern. Congress Plant Sciences, Ithaca (1926), Vol. 2, pp. 1107–1121, the Collegiate Press, Menasha, Wisconsin, 1929.

[15] Theodor Remy, "Untersuchungen über das Kalidüngerbedürfnis der Gerste," Paul Parey, Berlin, 1898.

[16] F. Sekera, *Ztschr. für Pflanzenernähr. u. Düngung*, 7–B: 533–539, 1926.

[17] D. D. Waynick, *Univ. Calif. Pub. Agr. Sci.*, 3: 135–242, 1918.

in culture solutions greater antagonism between 0.04 M $MgSO_4$ + 0.18 M KCl than from mixtures containing higher concentrations of $MgSO_4$.

The factors involved in the absorption of salts (or ions) by plants have been discussed by the writer,[18] and a recent paper by Cooper[12] presents some stimulating new ideas on the subject. The causal relations are known to be extremely complex. Nevertheless, although the factors producing differential absorption and influencing utilization of elements within the plant at the different planes of nutrition may not at the present stage of our knowledge be identified, the interpretation advanced to account for the discrepancy between Lagatu and Maume's results and those of the writer is the only one that, at the present stage, accounts for the observed facts. Details of the experiments will be published elsewhere.

WALTER THOMAS
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THE ORGANIC WORLD AND THE CAUSAL PRINCIPLE: A CRITICISM[1]

WITH some reservations, the theory of evolution as propounded by Darwin three quarters of a century ago is accepted by most psychologists of the present day. We use accepted advisedly. To the psychologist the view-point and all the accumulated data are gifts. As a group we have done little to advance this illuminating principle nor have we been greatly interested in understanding the far-reaching significance of its many aspects. We have been content to believe but not to strengthen the basis for belief. Ours has largely been a lip service to Darwin and this in spite of treatises of imposing titles purporting to deal with one or another aspect of the evolution of mental life. Having accepted evolution as fundamental to our science we have not oriented our concepts with regard to it. Not uncommonly we observe that an author may profess to a purely mechanistic viewpoint on one page and on the next offer "inhibition" as the solution of some felt difficulty. The "inhibition" is not evaluated in the light of the "mechanism." Inhibition, in any form in which we have seen it stated, is in opposition to at least one of those general principles which we have come to call the laws of nature.

Perhaps it is the feeling of a lack of critical evaluation of our concepts which leads our students to question whether or not psychology is a science. Possibly it is the same vague feeling on our part which motivates us either to spend valuable time and energy in demonstrating in our text-books and classrooms that psychology is a science, or to assume the "I don't care" attitude. That this lack has been felt is indicated in a new note that has recently been struck by Warren in his vice-presidential address. Warren clearly sees that a vast amount of revision must be made in our mode of thinking if we are to make full use of the principle of evolution. Primarily his article is an attempt to demonstrate that principles of causation characteristic of organisms may be assumed without damage to the mechanistic conception of life. Two such principles, he concludes, are natural selection and anticipation.

It is in hope of furthering rather than opposing the general point of view that we raise the question: Are these two principles characteristic of biological systems and are they causally related to evolution? There seem some grounds for believing that they are not, but before entering a discussion of causation it will be well to specify what we conceive the term to mean. A cause, we understand, is any event which directly or indirectly delivers energy to another event. A clear distinction must be made between causal factors and limiting factors. Silver nitrate in a transparent container undergoes certain changes when exposed to the sunlight. Causal efficacy will hardly be attributed to the container in so simple a case. Its only influence is to limit the amount of energy delivered to the solution by the sun. It is further evident that so long as we are dealing with one time frame the delivery of energy will take place only in the forward direction, and that the assumption of retroactive causation will make a hodge-podge out of all science. Cause must precede effect.

Of the supplementary causes which Warren conceives to be characteristic of organisms he says, "The first of these supplementary principles is that of natural selection. . . . It does not occur—it has no meaning whatever—except in connection with those peculiar groupings of molecules which we call organisms. . . . It is perhaps unnecessary to-day to emphasize the importance of selective adaptation[2] in promoting organic evolution. Through its means the organization of matter takes on an entirely new trend."

In communication with Warren he informs us that he does not conceive of natural selection as a cause but rather that it is based upon causation, and nowhere in his speech will the term "cause" be found when he refers to these supplementary principles.

[18] Walter Thomas, *Soil Sci.*, 27: 249–270, 1929; *Plant Physiology*, Vol. 5, No. 4, 1930 (forthcoming).

[1] A paper appearing in SCIENCE, February 21, 1930, bearing the same title, was the publication of Howard C. Warren's address as retiring vice-president and chairman of Section I—Psychology, American Association for the Advancement of Science, Des Moines, December, 1929.

[2] Natural selection and selective adaptation are used synonymously by Warren.

However, it must be pointed out that the above extracts indicate that causal efficacy is being attributed to natural selection. Only a cause can promote and only a cause can organize matter.

Natural selection is a term used to indicate that the survival of a system is limited by environmental conditions. Those organizations of matter which do not find themselves within the limitations imposed by the environment do not survive. Unfortunately we have come to speak of natural selection as acting in this or that way. It does not act in any way. It is not a force. It does not deliver energy to organisms. It limits in one way or another the delivery of energy to organisms and nothing more. Natural selection, then, since it is purely an abstraction and is quite devoid of energy, may not in any way be conceived to be causally related to evolution. It can not promote evolution and it can not organize matter. It is to be pointed out that Darwin did not make this error. He saw only too clearly that natural selection could but limit the forms that would continue to evolve.

It may be remarked in passing that it is even possible that we have overemphasized the importance of natural selection in limiting the survival of forms. We observe that a large number of widely divergent forms survive within the limitations of any given environment. If, as Claude Bernard and Beaunis have held, evolution is a characteristic of organisms, it follows that offspring will arise which are slightly different from, and perhaps slightly more complex than, the parent. Evolution, although characteristic of organisms, will not cause these changes. Rather evolution is the final result obtained from the summation or integration of the series of changes. The range of these differences will be wide, but since the organism may be considered as a Gibbs system the number of possible changes, or the degrees of freedom, will be expressed by the phase rule. Further, death, the return to equilibrium, also being characteristic of multicellular organisms, it follows that new forms will appear and the old forms disappear in an environment equally beneficent to all. Without doubt there have been cataclysmic changes at certain periods during the course of organic evolution, but it must be recognized that evolution goes on in the absence of such. Natural selection acts in no way to produce new forms. It can only limit the survival of whatever new forms may appear. The old question of the origin of variations remains unanswered by natural selection now just as in Darwin's time.

That natural selection "has no meaning whatever" except in connection with organisms is not apparent to us. Karl Pearson in his "Grammar of Science" has a chapter on natural selection in the inorganic world. This question seems to us to be merely one aspect of the phase rule. Water survives in its solid form at the earth's poles. Fresh-water lakes survive only in regions of moderate temperature. Certain rocks are selected for sands and certain sands selected for rocks. Natural selection is as old as evolution and evolution as old as the universe. Biological organisms are not new systems as Warren has stated. Organic and inorganic are both Gibbs systems. The difference between the two, as Baldwin has pointed out, is that the series of changes in living organisms is always irreversible.

Except for one, Warren foresees the arguments against his second supplementary principle, as is evident from the following extract:

> Recently a tornado was reported in the Caribbean Sea moving in the direction of Florida. Preparations were made at once to prevent the loss of life and minimize the damage to property. Ships altered their course. Buildings were shored up. Dwellers in the everglades were transferred to more elevated ground. All these activities were in response to what stimuli? In a measure they were reactions to present verbal stimuli—telegrams, storm signals, newspaper bulletins, radio messages, individual warnings by word of mouth. I have no doubt but that if a superscientist were to trace the cause-and-effect relations of this series of responses in the case of any person involved, he would find that the fundamental causal principle[3] accounted fully for the person's activity. But this causal explanation does not exhaust the meaning of the behavior. The activity of some thousands of individuals in this instance has reference to a certain future situation as well as to the present. As a matter of fact, in cases like this the immediate antecedents (the verbal stimuli) may be regarded as merely incidental—the responses were primarily to stimuli which were yet to come.

In psychology we are accustomed to say that a response is determined by the condition of an organism and the stimuli acting on it. Warren's example provides no exception to this general statement, we believe. Energy is stored up by metabolism and other processes in the anterior end of the central nervous axis of the Florida inhabitants in the form of learning. This in part determines the condition of the organism, the remainder being determined by the present stimuli. That the present response is neither "primarily" nor even remotely caused by "stimuli which were yet to come" is apparent when we recall that frequently under the above conditions, after all the responses have been made, the event "tornado in Florida" does not materialize. We should then have a response without a stimulus. Responses do not transcend their stimuli. There can be no "referring to" some future stimuli. The Florida

[3] The law of conservation of energy.

tornado is in no way a cause of the Florida activity. Energy is not retroactive. Event A, happening to-day, can not be influenced by event B, happening to-morrow. A and B may influence C, and in Warren's example the shoring up of the houses is an important cause of a later event which is "intact houses" after the tornado. Warren, we believe, has interpreted the effects of past experience, learning, as being the effect of some event which may or may not occur at some future time.

Warren has not demonstrated any new causes or principles in evolution. His examples are not energy manifestations, though he appears to use them as such. Any search for causal factors must be directed towards the possible sources from which organisms may derive energy. As has been pointed out by one of us,[4] there seems only one source available for all organisms, and this, the energy of the sunlight, is the motive force behind the appearance and evolution of organisms on the face of the earth. The series of living organisms is a series upon which work has been done, and in the source of this work we are to seek for the cause of evolution.

M. N. Chappell
F. H. Pike
Columbia University

SPECIAL CORRESPONDENCE

THE PALEOBOTANICAL EXCURSION OF THE FIFTH INTERNATIONAL BOTANICAL CONGRESS

Immediately following the close of the Fifth International Botanical Congress at Cambridge, England, on August 23, 1930, a tour was undertaken for the purpose of visiting some of the fossil plant localities in England and Wales. The tour was organized by Dr. H. H. Thomas, of Cambridge, and was conducted by Mr. W. N. Edwards, of the British Museum.

The party left Cambridge by motor bus on the afternoon of August 23 for Cayton Bay, near Scarborough, on the Yorkshire coast. Here, under the direction of Dr. Thomas, the Upper Jurassic beds containing the oldest known angiosperms, the Caytoniales, were visited and an opportunity was given to collect material.

The party then proceeded to Leeds where, under the direction of Dr. Hudson, several localities were visited for upper Carboniferous plants. Leaving Leeds the route followed was across the Pennine Moors to Manchester, where two days were spent. Besides visiting the coal mines in the vicinity of Manchester the party was entertained at tea by the botany department of the university and an opportunity was given to examine the magnificent fossil collection in the geological museum.

The party was then accompanied by Dr. John Walton, of Manchester, to north Wales. The first objective was the Teilia quarry near the village of Gwaenysgor for lower Carboniferous plants. Afterwards the Archeosigillaria beds at Denbigh were visited.

The south Wales coal field was the next objective. The route followed was along the scenic highway to Llangollen, then through Shrewsbury and Brecon to Swansea, which is one of the two centers of the coal industry in south Wales. On arriving at Swansea the party was entertained at tea by the mayor and at luncheon the next day by Captain H. Rees, of the Cefn Coed Colliery at Crynant. During the two days following the arrival at Swansea the party was conducted by Dr. A. E. Trueman, of the University College at Swansea, and Miss Emily Dix, of London. Numerous coal mines in the middle and transition Coal Measures were visited and rather extensive collections were made. On the evening of the last day the party was entertained at dinner by the Swansea District of the Monmouthshire and South Wales Coal Owners' Association and the South Wales Institute of Engineers.

The trip was concluded by visiting the mines in the vicinity of Bristol, Gloucester and Bath for upper Carboniferous plants under the direction of Dr. Crookall, of the British Geological Survey. The party then proceeded to London.

The participants of the tour were the following: Dr. T. G. Halle and Baron von Post (Stockholm); Dr. O. A. Høeg (Trondhjem); Professor A. Renier and Mme. Ledoux (Brussels); Professor and Mme. Jongmans (Heerlen); Professor W. Gothan (Berlin); Professor and Frau Hirmer (München); Dr. Sze (China); Professor Rudolph (Prague); Mr. W. N. Edwards and Miss E. Dix (London); Dr. G. R. Wieland (Yale), and Dr. C. A. Arnold (Michigan). Professor B. Sahni (Lucknow) and Dr. J. Pia (Vienna) accompanied the party for the first couple of days.

Chester A. Arnold
University of Michigan

SUMMER INSTITUTE FOR BIOLOGICAL RESEARCH AT AMOY, CHINA

The first attempt at a marine biological station in China was begun this summer at Amoy in southeast-

[4] F. H. Pike, *Ecology*, 10: 167–176, 1929.

ern China. For years the biologists in China have been exploring different parts of the coast to decide where such a station could best be placed. The north China coast is singularly poor faunistically. Here at Amoy the marine fauna is rich and various, a transition region between the Palearctic and oriental forms. There are sandy beaches, mud flats and rocky islands, and near here is the famous amphioxus fishing ground where amphioxus is caught by the ton and sold for food at four cents gold a pound.

Amoy has a university situated directly on the coast, with a modern well-equipped biology laboratory building. Dr. T. Y. Chen (one of Professor T. H. Morgan's students), who is now professor of zoology at Amoy University, with the cooperation of President Lim Boon-Keng, a university president with a real interest in scientific development, and the financial assistance of the China Foundation for the Promotion of Education and Culture, of which Mr. H. C. Zen is chairman, has opened the Amoy Biological Laboratory for summer research work and invited a group of about twenty-five biologists as guests the past summer, to initiate a China Marine Laboratory. The group has the usual international character of every science gathering in China—Chinese, American, British and German. We have been most hospitably entertained by the university, living in the buildings and eating at a common mess. Fifteen institutions are represented: Northeastern University in Mukden, Yenching University and Peking Union Medical College in Peking, Ginling College in Nanking, Soochow University, Shanghai College and Chi-Nan University in Shanghai, Hangchow College, Nanchang Academy, Fukien Christian University in Foochow, Amoy University and Anglo-Chinese College in Amoy, Lingnan University and Sun Yat Sen University in Canton, and the University of Washington in Seattle.

The research has been of several types, faunistic, experimental and cytological, concentrating on living amphioxus, but including also Teredo, Squilla, fishes, amphibia, insects, protozoa. The actual results of this first summer may not be great, but it is a beginning.

Dr. Chen is starting a supply service to furnish Chinese marine forms to the laboratories of China. This ought to be a good supplement to the world supply of amphioxus.

This whole venture is an instance of President Lim's scientific enthusiasm and one more of the far-sighted ways in which the China Foundation is encouraging science development in China. Biologists on sabbatical trips around the world ought to stop at Amoy. It lies half way between Shanghai and Hong Kong and can be reached by coast steamer from either port.

A. M. BORING

YENCHING UNIVERSITY

QUOTATIONS

WARD'S NATURAL SCIENCE ESTABLISHMENT

THE cradle of taxidermy in this country was destroyed when Ward's Natural Science Establishment in Rochester, with its irreplaceable collections, went up in smoke. Many a man who later became famous as a naturalist started his career as an apprentice at Ward's, stuffing birds and fishes and four-legged beasts. One of them, the late Carl Akeley, walked through the jaws of the sperm whale at the entrance when a youth of 19 and gleefully accepted a job at $3.50 a week, although the cheapest board and lodging he could find in Rochester cost him half a dollar more. His book, "In Brightest Africa," contains a list of some of the young enthusiasts he knew there or who preceded him—E. N. Gueret, George K. Cherrie, J. William Critchley, H. C. Denslow, William T. Hornaday, Henry L. Ward, Frederick S. Webster, Frederic A. Lucas, William Morton Wheeler. The roster reads like a page from a naturalist's Who's Who.

Taxidermy in those days was rather a trade than an art. The skin of an animal was first treated with salt, alum and arsenical soap. After the bones had been wired and put in there was nothing more to do but hang the body upside down and stuff it with straw until it would hold no more. No attempt was made to put the animal in a natural attitude. The reason for this crude work, Akeley explains, was not that Professor Ward and his assistants knew no better, but that nobody would pay for better work. The museums for which the establishment prepared specimens cared more for purely scientific data than for exhibitions that would interest the public. They had no taxidermists of their own and generally preferred collections of skins and skeletons to mounted groups. Ward's men would tackle anything from a humming bird to an elephant. Their largest job was the stuffing of Barnum's mighty Jumbo. The mounted skin of this most famous of pachyderms is at Tufts College; its skeleton is in the American Museum of Natural History in this city.

For the present artistic perfection and scientific accuracy of taxidermy Akeley deserves a great share of the credit. He invented many new methods. He was one of the first to realize the importance of a

knowledge of animal anatomy, and his natural bent for sculpture gave an artistic quality to all his work. The modern taxidermist, instead of stuffing the skin of an animal with straw and rags, mounts it on a waterproof manikin made whenever possible from a plaster cast of the body. The animal is seldom placed on display without a stage setting suggesting its proper habitat. It is a far cry from the Ward's Natural Science Establishment of Akeley's youth to the great institution at Central Park West and Seventy-seventh Street, but in numerous respects Ward's led the way.—*The New York Sun.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR WORKING ON THE TERMINAL NERVE-MUSCLE UNIT

THE method here described[1] makes possible a direct experimental study of the terminal motor axone with its attached muscle fiber. Thus, in one field and focal plane with active circulation, an ultimate member of the motor-unit can be identified, operated upon and selectively stimulated under the compound microscope.

A technique employed by us for recording *in situ* by reflected light the mechanical response of muscle fibers in the retrolingual membrane (*membrana basihyoidea*) of the frog has recently been reported.[2] On noting in this structure the frequent presence of terminal nerve filaments (from *n. hypoglossus*) we have since met the requirement of transmitted light by a procedure similar to that devised by Richard Thoma for the observation of leucocyte migration and published at Heidelberg[3] in 1873. Both nerves and muscle fibers are mentioned by Thoma, who points out the many conditions fulfilled by the preparation in the study of living tissue elements.

The intrinsic lingual muscle fibers (*stratum arcuatum* Gaupp) which from either side enter this delicate membrane bounding dorsally the extended tongue form a transversely, somewhat sparsely disposed branching and anastomosing system. The fibers, though suggesting thus an interconducting syncytium, are nevertheless partitioned into discrete members each of which is of the striated-voluntary type. Since Thoma's observations these fibers have from time to time been an object of interest to workers on muscle structure and function, notably Ranvier[4] and Kahn,[5] and have come recently under special notice in a fruitful examination of the credentials of the all-or-none law.[6]

[1] *Cf.* abstract, F. H. Pratt and M. A. Reid, *Proc.* Am. Physiol. Soc. (Chicago meeting, March 28–29, 1930); *Am. J. Physiol.*, 93: 681, 1930.

[2] F. H. Pratt, *Am. J. Physiol.*, 93: 9, 1930.

[3] Verlagsbuchhandl. v. Fr. Bassermann. Buchdruck., G. Otto, Darmstadt.

[4] L. Ranvier, *Compt. Rend. Acad. Sci.*, 110: 504, 613, 1890.

[5] R. H. Kahn, *Zentralbl. f. Physiol.*, 17: 745, 1903–04.

[6] E. Fischl and R. H. Kahn, *Pfl. Arch.*, 219: 33, 1928; F. H. Pratt and M. A. Reid, *Proc.* XIII Int. Physiol. Cong., *Am. J. Physiol.*, 90: 480, 1929; S. Gelfan, *Am. J. Physiol.*, 93: 1, 650, 1930; H. Hintner, *Pfl. Arch.*, 224: 603, 1930; F. H. Pratt, *loc. cit.*

The *motor-unit*, a term introduced by Sherrington[7] to denote the nerve fiber with the muscle fibers governed by it, is known to be adapted in its pattern to the directional demands on the muscle in developing tension. Thus in the sartorius[8] the motor-unit is linear in disposition, involving formation in files of the "squad"[9] of muscle fibers under command of the neurone. This close formation of a group intimately bound into the muscular matrix offers little feasibility of detailed inspection *in vivo*. With the retrolingual membrane, however, the tension requirement is highly diffuse;[10] it is correlated with a dispersion or deployment of the muscle-squad in essentially one plane, the fibers being none the less completely integrated through the nerve strands passing along and across the intervals formed by the divergence and loose intertexture of the musculature (Fig. 2) as it invades the membrane from the arcuate layer. It should therefore be possible, with proper illumination and control, to take practical advantage of this natural isolation of what may be termed respectively a motor sub-unit (branch system subordinate to the motor-unit) and the motor-terminal (ultimate sub-unit—the innervated muscle fiber).

In Thoma's method[11] the everted tongue is stretched over a glass plate after an opening for transmission of light has been made in what is now the floor of the superficial lymph sac (*sinus basihyoideus*). This admits of continued circulation, the preparation being kept moist by irrigation. With the present modification, however, it is unnecessary to stretch the tissues since a glass disc or cylinder supports the membrane and fills the opening beneath it, with the further advantage that manipulation is afforded without deranging the focal position; as, for example, in the mechanical blocking of impulses in single nerve fibers. Even with extensive pithing the capillary circulation in the preparation may be highly active and persistent, all tissues under observation being immersed.

[7] C. S. Sherrington, *Proc. Roy. Soc.* B, 105: 332, 1929; J. C. Eccles and C. S. Sherrington, *ibid.*, 106: 326, 1930.

[8] S. Cooper, *J. Physiol.*, 67: 1, 1929.

[9] E. L. Porter, *Am. J. Physiol.*, 91: 345, 1929.

[10] R. H. Kahn, *loc. cit.*

[11] R. Thoma (illustrated description), Abderhalden's Handb., V, 4, 1924, p. 1928.

A disc made from a segment of glass rod (about 5 x 4 mm for *R. pipiens*) is cemented with balsam to a glass plate (*a*, Fig. 1). The tongue of the pithed or narcotized frog is everted and an incision made through its mid-region as far as the membrane, avoiding undue hemorrhage from the rich bilateral vascular supply. The preparation is now adjusted (prone position) so that the tongue, *b*, rests on the plate above mentioned, with the disc penetrating the open-

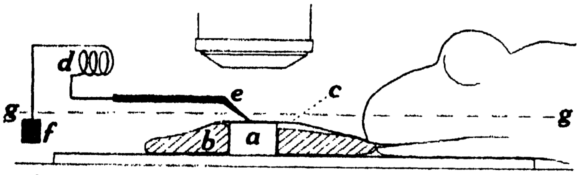

FIG. 1. *a*, glass disc cemented to slide; *b*, tongue (mid-sagittal section); *c*, retrolingual membrane; *d*, secondary coil; *e*, active electrode; *f*, indifferent electrode; *g–g*, submersion level.

ing so as to support the endothelial surface of the membrane. The entire preparation is laid in a Petri dish and covered with Ringer's fluid to above the level of the membrane, which may now be transilluminated under the microscope and at the same time manipulated from above. Although low powers suffice for most experiments a high-power objective immersed in the solution gives excellent definition.

For stimulation the unipolar method is conveniently used. An indifferent terminal rests in the bath covering the preparation. The active electrode may take various forms; we have worked largely with quartz-covered platinum electrodes (diameters between 2 and 10 µ) of the type described by Taylor,[12] carried in a manipulator mounted integral with the carriage of the preparation. A micro-needle in a second manipulator is readily added to the apparatus. By means of this system single or faradic induction shocks are delivered to any point in the field, the intensity being graduated over a wide range with great delicacy by coarse and fine sliding rheostats—the former in series with the primary circuit, the latter on a shunt across the primary terminals in series with a further set of resistances variable up to 11000 ohms.

On exciting a single motor nerve fiber (see Fig. 2) it is very readily evident that the responding muscle fibers are those limited to innervation by the ramifying nerve filaments of the unit, that the nerve threshold is distinctly lower than the muscle threshold and that one has to deal with a system having a capacity of performance not only independent of changes in the intensity of stimulation but, so long as other factors are in abeyance, of unvarying char-

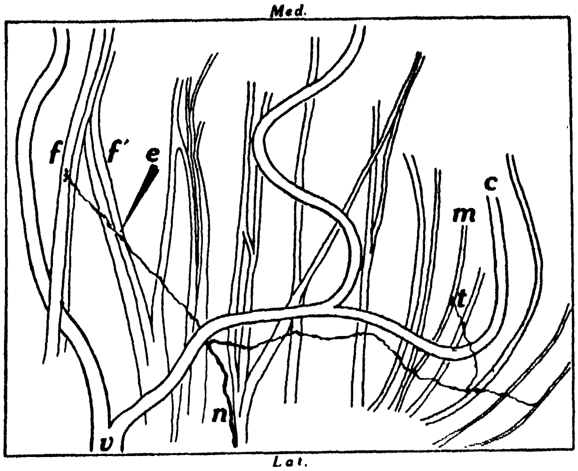

FIG. 2. Outline based on a typical nerve-containing field, retrolingual membrane, × 50: *v*, vein; *c*, capillary; *n*, myelinate nerve fiber; *t*, one of its terminal filaments; *m*, one of a sub-unit group of muscle fibers that respond with the motor-unit to stimulation by *e*, the active electrode (axone reflex). If the nerve be cut or compressed between the contact of *e* and the structures central to it, and again stimulated, only the muscle fibers (*f*, *f′*) distal to the block respond. If the electrode be moved slightly from the nerve the fiber *f′* alone responds, but at a higher threshold. Being thus directly excited it may, especially if touched, show partial, gradable contractions as described by Gelfan and by Hintner (*loc. cit.*) and, for the sartorius, by Brown and Sichel.[15] The outline is semi-diagrammatic and slightly composite. No morphologic interpretation is here to be placed upon detail indicating contacts between nerve and muscle.

acter. Functional isolation of one motor-terminal is to be obtained by cutting or otherwise blocking the filaments passing to other muscle fibers of the unit, or by actual destruction of such fibers. The area of innervation (locus of "end-organ") appears with sufficient definition to enable the observer to manipulate the electrode with a considerable degree of selectivity. The persistence of thresholds, which are obtainable with great exactitude, appears to be correlated with the circulatory conditions. Frequently a muscle fiber with the innervating collateral is in immediate relation to an actively conducting capillary the walls of which are defined in optical section with extreme clearness. After circulatory failure or mechanical injury,[13] or in the course of fatigue or curarization,[14] the relative excitatory conditions of axone and muscle fiber are again readily investigated; the effect of nerve

[12] C. V. Taylor, *Proc. Soc. Exp. Biol. & Med.*, 23: 147, 1925.

[13] Our results are here in agreement with Hintner's (*loc. cit.*) observations on stimulation of the hypoglossal nerve in the excised tongue.

[14] F. H. Pratt, *Proc.* Am. Physiol. Soc. (Chicago meeting, March, 27–29, 1930); *Am. J. Physiol.*, 93: 608, 1930.

[15] D. E. S. Brown and F. J. M. Sichel, SCIENCE, 72: 17, July 4, 1930.

fiber on muscle fiber has so far proved consistently maximal.

Frederick H. Pratt
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A NEW TECHNIQUE IN TREE MEDICATION FOR THE CONTROL OF BARK BEETLES[1]

The possibility of injecting chemicals into the sap stream of living trees in order to inhibit the action of parasitic organisms or correct some pathological condition has appealed to botanists and entomologists for a number of years. Variations of this method of control have likewise been utilized by so-called "tree doctors" to reap no inconsiderable return from unsuspecting owners of valuable shade trees, usually without accomplishing the desired results. A number of valuable contributions in this field and on related subjects have been made as a result of careful experimental work.[2] That it is possible to introduce fluids into the sap stream has been conclusively demonstrated, but in most cases the results have been of limited practical value. This is because usually these substances are not well distributed through all portions of the tree. Good distribution, even to the leaves, has been reported in those portions of the tree in direct communication with the point of injection, but the lateral dissemination has usually been slight.

In the summer of 1925, following the publication of results obtained by Lipman and Gordon,[3] the writers and Mr. J. A. Beal at Asheville, North Carolina, attempted to use the method therein described to destroy the developing broods of the southern pine beetle (*Dendroctonus frontalis* Zimm.) in shortleaf pine. It might be explained here, in reference to this insect, that these beetles attack the trees simultaneously in great numbers, bore through the bark and in about ten to fifteen days completely girdle the inner phloem and at the same time introduce blue-stain.[4] The trees after attack are necessarily doomed and, for the objective at hand, there was no effort made to save them. It was desired merely to kill the developing broods under the bark and thus prevent their escape and attack of other living trees. The control practices now in use for the bark beetles of the genus Dendroctonus consist in felling the tree and either peeling or burning the bark of the entire tree or other practices that destroy the broods, at a cost ranging from 75 cents to $5 per tree, depending on the size. It was hoped that these costs for treatment might be greatly reduced by some such method as that described.

Work was continued through 1926, 1927 and 1928. The results obtained were very conflicting. A high percentage of brood mortality occurred in some trees and with some chemicals, but in general the insects were killed only in a narrow strip above the point or points of injection. It was obvious that the idea might be practical but that the technique was poor; in other words, more thorough lateral distribution of the chemical was needed.

In the meantime several patents had been issued describing various methods of obtaining complete distribution of dye or preservatives in the tree. These were all too elaborate and expensive for the purposes intended. It occurred to the senior author that a combination of the technique already in use and the ringing practice used by orchardists to stimulate the setting of fruit buds might be more effective. Accordingly, during the summer of 1929 approximately two hundred trees were treated by the authors and R. W. Caird, the latter working chiefly on the physiological aspects of the problem.

The technique adopted was as follows.

(1) At a convenient working distance near the base of the tree the bark is first smoothed completely around the tree by the use of a wood rasp or draw knife to such a degree that it will permit a water-tight application.

(2) The next step consists in making a narrow (one eighth to one fourth inch) incision or notch completely around the circumference of the tree, by means of a saw or sharp knife, through the bark, and through two or more annual layers of wood, or through the entire sapwood, depending on the depth of penetration desired. This incision is located on that portion of the bark which has been smoothed.

(3) On one side of the tree an auger hole about

[1] Publication of the results obtained by the Bureau of Entomology at this time while the investigations are still in an experimental stage seems justified largely because a technique appears to have been developed which has some advantage over those previously described. It should be distinctly understood, however, that the Bureau of Entomology is not at this time advocating the use of this method for general application in the control of insects.

After this article had been prepared, Dr. Caroline Rumbold called our attention to the use of a somewhat similar technique by M. A. Boucherie, "Mémoire sur la conservation des bois," *Annales de Chimie et de Physique*," 74: 113–157, 1840.

[2] J. Davidson and H. Henson, "The Internal Condition of the Host Plant in Relation to Insect Attack, with Special Reference to the Influence of Pyridine," *Ann. Appl. Biol.*, 16: 458–471, 1929; A. Muller, "Die innere Therapie der Pflanzen," Monograph angew. Ent. 8, pp. vi–206, illus., 1926 (abstract in *Rev. Appl. Ent.*, 14, Ser. A: 505); C. T. Rumbold, "The Injection of Chemicals into Chestnut Trees," *Am. Jour. Bot.*, 7: 1–20, 1920.

[3] C. B. Lipman and A. Gordon, "Further Studies on New Methods in the Physiology and Pathology of Plants," *Jour. Gen. Physiol.*, 7: 615–623, 1925.

[4] F. C. Craighead, "Interrelation of Tree-Killing Barkbeetles (Dendroctonus) and Blue Stains," *Jour. Forestry*, 26: 886–887, 1928; R. M. Nelson and J. A. Beal, "Experiments with Blue-stain Fungi in Southern Pines," *Phytopathology*, 19: 1101–1106, 1929.

one half inch in diameter and centering on the notch is bored into the tree to a depth of about one inch.

(4) Two methods have been used for making a water-tight connection around the tree. A strip of rubber band about two inches wide, such as old inner tubing, is stretched around the tree covering the notch and placed preferably so as to overlap at the point where the one half inch auger hole is bored. This bandage can be held by several nails or by wire tourniquets above and below. The other method consists in the use of an impervious plastic putty or waxlike material (grafting wax, asphaltum paste or tree gums) that will adhere readily to the bark. This method has advantages on trees of irregular circumference. Grafting wax has proved to be the most practical material tried.

(5) At a convenient distance, a few inches to a foot or more above the incision, a container is hung on the tree for the purpose of holding the liquid to be injected into the tree. This container is connected to the notch by means of a short section of rubber tubing terminating in a piece of metal pipe about one fourth inch in diameter. This pipe making contact with the container is connected to the circumferential notch through the one half inch auger hole and sealed by the plastic material used or by pushing it through the rubber bandage around the notch.

By means of this technique, from two quarts to several gallons of liquid, depending on the quantity required, can be injected into the tree in a few hours and thorough distribution obtained through all the outer annual rings severed and to the topmost branches and leaves. Two quarts was ample in most cases on the relatively small trees used. The quantity varies, depending on the concentration of chemicals employed and size of tree treated.

In general, the results were most encouraging. Complete brood mortality was obtained in practically all cases with certain chemicals, provided the application was made before the sapwood became blue-stained by associated fungi[4] and the ascending sap stream disturbed. The following table summarizes a few of the materials used, the quantities and the results obtained.

CHEMICAL SOLUTIONS USED IN TECHNIQUE DESCRIBED IN TREATING SHORTLEAF PINES INFESTED BY THE SOUTHERN PINE BEETLE AT ASHEVILLE, NORTH CAROLINA, 1929

Number of trees	Materials used in treatment*	Results of treatment: Number of trees in which the brood mortality was 100 per cent. and in which there was no blue stain (adults and eggs the only beetle stages present)	Results of treatment: Number of trees in which the brood mortality was only partial and in which there was blue stain (larval and more advanced beetle stages present)
17	Wood alcohol	10	7
11	Carbon disulphid and kerosene, equal parts	4	7
5	Copper sulphate and water, 50 grams	2	3
1	Ethylmonochloro-acetate	1	0
7	Ethylene dichloride	3	4
4	Formaldehyde and water, 1 pt. 40 per cent.	2	2
25	Hydrocyanic acid and water, 5 per cent.	16	9
2	Mercuric chloride and water, 15 grams	2	0
32	Potassium cyanide and water, 30 to 50 grams	15	17
8	Sodium arsenite and water, 30 grams	4	4
7	Sodium fluoride and water, 30 grams	4	3
Total 119		63	56

* Average dosage, 2 quarts of solution for pine trees 5½ inches in diameter breast height and 30 feet high. The diameters of the trees ranged from 4 to 18 inches and the height from 20 to 60 feet.

Although the writers have made no attempts to use dilute solutions with the idea of killing the insects and saving the tree, it is within the realm of possibility that with sufficient experimentation this objective could be attained. In the case of trees (conifers) that are more susceptible to this girdling of the cambium two or more breaks in the notch can be left on the circumference, which will greatly accelerate subsequent healing,[5] and the notches connected with a drill, or an additional container or attachment used with each notch. With most hard-woods the narrow saw cut completely encircling the tree will not cause death, but with conifers over 50 per cent. of the trees so treated as checks died.

Some tests have been made on the possibilities of utilizing this process for the injection of wood preservatives into the sapwood before felling the tree. Trees were treated with commonly used preservatives,

[5] This may not be necessary where grafting wax is used.

such as zinc chloride, copper sulphate, sodium fluoride and arsenicals, and the logs from these trees were set in the ground with untreated checks. Ordinarily in wood-impregnation processes only the sapwood is treated, to the depth of one inch or so. This method brings about the same results by use of forces within the living tree.

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SPECIAL ARTICLES

A GENERAL THEORY FOR CALCULATING SURFACE TENSION FROM THE SHAPES OF STABLE LIQUID SURFACES OF REVOLUTION

THE general significance of Laplace's theory of liquid surfaces in the interpretation of all those methods for the determination of surface tension involving stable surfaces of revolution has not been commonly appreciated. The usual application of this theory has been through the integration of its differential equation by the use of particular assumptions. But these assumptions limit the generality of the underlying theory. In a few special cases, it is true, the theory has been applied without limiting assumptions, but even in these cases no hint has been given that the particular applications had general significance. Some methods are associated with this theory only empirically. It is the purpose of this note to state that all surface tension methods involving the use of stable liquid surfaces of revolution may be based upon the Laplace theory alone and that all of them thus are absolute methods in the sense that the value of the surface tension may be obtained from them without the use of limiting assumptions or the necessity for empirical comparison with another method.

The essence of this general method for calculating the value of the surface tension of a liquid is as follows. Draw, from the Laplace equation, the family of curves giving the shape of the surface assumed by the liquid in any of the experimental methods of this group; perform on this family of curves an operation analogous to the experimental procedure of any one of these methods, which gives a pair of corresponding quantities; construct from a number of such operations a curve one of whose coordinates is a dimensionless function of these quantities, while the other is a function the equivalent of which, for any particular liquid, involves its surface tension; and finally use this curve in connection with a measurement on the liquid whose surface tension is sought.

The shapes, though not the sizes, of liquid surfaces of revolution may be found by numerical integration of the equation expressing the Laplace theory:

$$\frac{du}{dx}+\frac{u}{x}=2(h\pm y)$$

where the terms on the left may be considered as dimensionless ratios obtained by dividing the square root of the capillary constant of the liquid by the radii of curvature of the surface at any point, while that on the right is a ratio obtained by dividing by the square root of the capillary constant the height of a column of the liquid that would exert the pressure which exists at that point. To make this equation apply to any liquid, x, y, and h must each be multiplied by the square root of the capillary constant of that liquid, a. Numerical integration of this equation gives the various families of curves representing these surfaces, which fall into three groups which we have designated by the names meniscus, disk and drop profiles. From these families of profiles it is possible to derive a general theory for all the methods for the determination of surface tension which involve such surfaces.

An outline of our procedure by which relationships between the dimensionless quantities of the equation are used to calculate the value of the surface tension of a particular liquid will be given and illustrated by application to the capillary rise method. The first step is the preparation, from the equation, of a family of meniscus profiles, since this is the shape of the surface in a capillary tube. For the details of this step, which is rather involved especially when the data in the literature are not adequate, reference should be made to the papers mentioned below. In the second step the family of profiles is made to give the values of two dimensionless quantities, the analogues of which are measured in the experiment. In the capillary rise method these quantities are the radius of the tube and the height of the liquid in the tube between the undisturbed level of the liquid and the bottom of the meniscus. The analogous procedure is the selection of a particular value of x, which is equivalent to choosing a definite capillary and a definite liquid; the finding of that member of the meniscus family of curves which is tangent to the constant x line selected, the reading off of the value of the ordinate, y_0, of the point where this meniscus curve crosses the y-axis; and of the repetition of this procedure for other selected values of x. In the third step, from these pairs of corresponding values of x and y_0, a curve is constructed having for one coordinate a function of these quantities, whose identical function in the case of the analogous experimentally measured quantities is dimensionless, and for the other coordinate a function of x and y_0 whose equivalent function in the case of the analogous real quan-

tities must involve the capillary constant. In the capillary rise method the abscissa might conveniently be y_0/x which is dimensionless, and the ordinate y_0x whose analogue involves the capillary constant a^2 and so the surface tension. This curve is independent of any determination of surface tension and is applicable to all liquids. By means of these three steps the Laplace equation is now expressed in a form suitable for application to the measurement of the surface tension of an unknown liquid. In the capillary height method this fourth step is the determination of one pair of corresponding values of the radius, r, of a capillary tube and the height, h, of the liquid in it. From these the ratio h/r may be calculated which is the analogue of and equal to y_0/x. From this value of h/r and from the curve, the corresponding value of y_0x is read off. This must now be expressed in terms of similar quantities which are not dimensionless and which involve the characteristics of the particular liquid we are working with; that is, we must put back the capillary constant in the Laplace equation. This is the equivalent of saying that the y_0x read from the curve is equal, in the case of a particular liquid, to hr/a^2. Thus, knowing the value of y_0x from the curve and the values of h and of r from the experiment, the value of a^2 can be calculated.

For a detailed description of this procedure reference may be made to our application of it to the ring method for the determination of surface tension.[1] The scheme may be applied rigorously to all methods involving only stable liquid surfaces of revolution. We have indicated its application to the capillary height, bubble pressure and sessile drop methods, which involve meniscus profiles; to the pull on a disk and a sphere, which involve disk profiles; to the ring method, which involves both meniscus and disk profiles, and to various drop shape methods which involve drop profiles. The convenient and precise drop weight method, involving as it does a dynamic condition, does not come under this scheme.[2] Thus a single theory for all those methods of determining surface tension using stable liquid surfaces of revolution has been developed. Wherever the calculations based on the theory have been compared with the results of experiment, agreement has been observed within the limits of precision of the particular experiment. All these methods, we think, may therefore be considered absolute ones.

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[1] Science, 71: 345, 1930; *Jour. Am. Chem. Soc.*, 52: 1772, 1930.
[2] *Jour. Phys. Chem.*, 33: 1217, 1929.

"RIGHT-HANDEDNESS" IN WHITE RATS[1]

This report[2] is concerned with the problem of left- and right-handedness. The problem is one of biological, pathological and psychological interest. Biologically, we are interested in the origin, evolution and heredity of bilateral asymmetry which is expressed functionally in hand preference. Pathologically, the problem is often related to speech defect, facial paralysis, epilepsy and feeble-mindedness. Psychologically, we are interested in the acquisition, retention and modification of hand preference.

Statistical studies show that in human beings there are about 95 per cent. who are right-handed, whereas only 5 per cent. prefer to use the left hand. The question immediately arises as to why it is that the great majority of people are right-handed. Up to the present time there have been about five hundred articles published by various scientists to answer the question, but the solution of the problem still remains a mystery. We know very little as to why some people are left-handed while others are right-handed —as little as we know why some of the stars in the sky rotate on their axes from left to right while others rotate in the opposite direction.

However, various theories have been advanced to account for the phenomenon of hand preference. One theory says it is entirely a matter of habit. Now if it were entirely a matter of habit, we should expect that chances are fifty-fifty. We know that habit is formed through repetition. Repetition of what? Repetition of the initial accidental chance fixation. Now we have two hands. And if handedness were entirely a matter of habit, without any organic, environmental or social influence, then it is statistically logical that chances are fifty-fifty. To illustrate, Tsai has studied the ways people clasp their hands. Each person has his habitual way of clasping the hands. Some people clasp their hands with the left thumb uppermost, while others clasp with the right thumb on top. He found that this has nothing to do with handedness, but that the results turned out to be fifty-fifty. This can be very well explained by the theory of habit, which does not seem to account for the fact that 95 per cent. of people are right-handed.

The next theory says it is a matter of social tradition. When we are young, we are ambidextrous— and experiments show that it is true up to the age of about six months. Then society steps in and says, "Thou shalt use thy right-hand!" So we were trained by our parents to be right-handed in handling the fork or the chop-sticks, as the case may be, in shaking hands and in doing a thousand other things. But why

[1] Read before the Midwestern Psychological Association, May 23, 1930.
[2] From the Otho S. A. Sprague Memorial Institute and the departments of pathology and psychology of the University of Chicago.

is it that our parents train us to be right-handed? Well, it is because they are right-handed. Why is it that they are right-handed? It is because their parents were right-handed. So the question is pushed back to the primitive people. Archeologists, by studying the direction of the grooves produced by the flaking of stone implements, have come to the conclusion that the great majority of the prehistoric men were right-handed. The question is, "Why?"

The theory of primitive warfare maintains that prehistoric man was essentially a fighting creature. And in fighting he used his right hand for attack, because the left hand was reserved for holding the shield to protect the heart which he thought to be on the left side of the body. This sounds very interesting. But why is it that there are 5 per cent. left-handed people who can never be trained to be right-handed? Is it because their hearts are on the right side of the body?

Perhaps the best-known theory seems to be that we are right-handed because we are left-brained. It has been pointed out, though not experimentally proved, that when a person is right-handed he is also, in a less marked degree, right-footed, right-eyed and right-eared. In other words, he is right-sided. Now, the movements of the right side of the body are controlled by the left side of the brain. So this theory holds that for the majority of people the left hemisphere of the brain is more highly developed. Now more highly developed in what sense? Is it anatomical, physiological or chemical? The relative size and weight of the two hemispheres have been compared, the microscopic structures of the brains have been examined, the normal arching of the aorta artery has been reversed, but no definite results have been obtained. So the problem is still unsettled. In this connection, we may mention that we have been doing some work in comparing the relative distribution of water in the two hemispheres. Although the preliminary data seem to correspond very closely to the percentage of handedness, we are not ready to draw any conclusion pending the further results of our investigation.

As to the evolution of handedness, nobody has ever published anything beyond the primates. Practically all the work has been done on human beings with a very few exceptions on higher apes and monkeys. The conclusions thus far have been that infra-human animals are all ambidextrous and that handedness is the outgrowth of human intelligence. To quote Parson, in his book, "Lefthandedness," the first sentence of Chapter VI runs, "Since no authentic traces of handedness have been found among animals, even among the Quadrumana, we are forced to the conclusion that whatever the immediate anatomical or physiological cause may be, handedness itself is probably in some way the outgrowth of man's intellectual development." Now we find that even such a low animal as the white rat exhibits definite hand preference. The discovery was made by Tsai early in February, 1929, and a technique was soon developed by him for this particular investigation. The animal was put in a wire cage with a small glass bottle of wheat embryo inserted through the wire bottom. The opening of the bottle was so small ($\frac{3}{4}$ inch in diameter) that it permitted the rat to use only one hand at a time for grasping food out of the container. Since both the cage and the opening of the bottle were circular, there existed apparently no environmental situation tending to favor the use of either hand. Two hundred and fifty observations were made on each animal. They were distributed evenly over five days, with five series in a day. After each series, which consisted of the observation of ten consecutive hand movements, the animal was temporarily removed while the bottle was again filled up to the original level about half an inch from the brim. The criterion of handedness is that any rat using the left hand (or the right hand) from 75 to 100 per cent. of the total 250 attempts is considered to be left-handed (or right-handed as the case may be), while any rat using either hand from 50 to 74 per cent. of the total attempts is classified as ambidextrous. One hundred and fifty-nine rats have been thus studied. Among them, 105 were normal rats, while 54 were vitamin B depleted rats who suffered through the depletion of their mothers during the nursing period. The results for the normal rats are presented in Tables I and II.

TABLE I

Handedness in Normal Rats

Handedness	Relative frequency in percentage	
	59 males	47 females
Right	59	43
Left	26	37
Ambidextrous	15	20

TABLE II

Handedness in Normal Rats Excluding Ambidexterity

Handedness	Relative frequency in percentage	
	Males	Females
Right	69	54
Left	31	46

The results show that the majority of normal rats of either sex are right-handed. This discovery throws light on the phylogenetic evolution of handedness and at the same time overthrows the theory of outgrowth of human intelligence, the theory of primitive warfare and the theory of social tradition.

As to the heredity of handedness, the results in the literature are conflicting. Most investigators maintain that if handedness is hereditary at all, it does not seem to follow the Mendelian ratio. In order to study ten generations of human beings, a few hundred years are required. But with our discovery, we can attack the very same problem with better control in a short time.

As to the pathological significance of the problem, let us cite the following investigations. L. G. Smith found that among 2,055 school children, 4.5 per cent. of the girls and 5.5 per cent. of the boys were left-handed. Out of 500 delinquent, 6 per cent. of the girls and 11 per cent. of the boys; out of 200 feeble-minded, 11 per cent. of the girls and 8.5 per cent. of the boys were found to be left-handed. R. Ganter also reports that 21.9 per cent. of the epileptics and 18.7 per cent. of the feeble-minded are left-handed. In an earlier investigation, we found that normal rats are far superior in maze learning to those which have been depleted of vitamin B complex through their mothers' diet during the nursing period. It is therefore of interest to find out the distribution of handedness among the vitamin B depleted rats. The results for the depleted animals are presented in Tables III and IV.

TABLE III

HANDEDNESS IN VITAMIN B DEPLETED RATS

Handedness	Relative frequency in percentage	
	27 males	27 females
Right	48	33
Left	48	45
Ambidextrous	4	22

TABLE IV

HANDEDNESS IN VITAMIN B DEPLETED RATS EXCLUDING AMBIDEXTERITY

Handedness	Relative frequency in percentage	
	Males	Females
Right	50	43
Left	50	57

Comparison of the results indicates that the percentage of left-handedness is higher in the vitamin B depleted animals whose maze-learning ability was found to be much inferior to that of the normal rats. These results do not necessitate the conclusion that the left-handed are mentally inferior. They merely indicate that the percentage of left-handedness is higher among the poor learners, and that's all. Perhaps when we study a group of geniuses, we may find that the percentage of left-handedness is also higher. Professor McCollum, of the Johns Hopkins University, suggested that we study the members of the National Academy of Sciences or the "Who's Who in America." Of course the left-handed person may or may not be a genius, but he has certainly proved to be a great star in the baseball game.

As to the psychological aspects of the problem, Tsai has studied the time required by the animal to change from the direct method of eating with mouth to the indirect method of eating "from-hand-to-mouth." Also he has studied the amount of time required by each animal for making fifty consecutive attempts of hand movements a day. Both results, when plotted against five successive days, represent the abrupt curves of negative acceleration. As to the retention of hand-preference, he found that rats practically use the same hand after a month's interval. As to the modification of hand preference, we have not done anything. However, the experiment can be very easily performed. First put a rat in the cage and find out whether he is left- or right-handed. If he is left-handed, the next time he uses his left hand again give him a mild electric shock. See how much training is required and how long he will continue to use the modified hand. Besides, modification may also be achieved by paralyzing the preferred hand either with drug or operation, and the changes be studied during and after recovery.

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POLAR EXPLORATION[1]

By Dr. ISAIAH BOWMAN

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IT was but yesterday in the procession of "the eternal years" that men sought knowledge of the higher will by consulting the oracle, the shrine where the voice could be heard that told what to do and what would happen. "There mighty Nations shall inquire their doom," and there the individual, if powerful enough, might even hope "to work the oracle" and bring private wish and future event into harmony. What men were striving after was fore-knowledge of the event, forecast, or, in another connotation and using the modern term of a scientist of the Indian Meteorological Department, "foreshadowing." It is rather striking that this early manifestation of human curiosity is reflected in the scientific era. Within the scope of its "laws," or, better said, its generalizations, science to-day sets up forecast as one of its highest aims. *Omitting California,* the most common question of civilization is, "What will the weather be to-day?" and, as Mark Jefferson has phrased it, if the forecaster can not tell us whether or not it will rain at least we wish him to tell us if it is prudent to carry an umbrella. In a state so well supplied with observatories and in the presence of such eminent astronomers I do not wish to draw upon even that nearer heaven, the sky, for further illustrations of forecast, but you will perhaps permit me to mention the tides and the celebrated tide machine of the U. S. Coast and Geodetic Survey that permits an operator to pull levers and scan indices and, at length, by what to the layman seems mystery as deep as an oracle, derive the future time of occurrence of the tide at a given point on the earth with all but mathematical accuracy!

It happens that polar exploration has participated in this advance from the place of wish-and-guess to the eye-piece of an instrument of precision and a knowledge of the workings of natural laws, and I have

[1] Public address under the auspices of the National Academy of Sciences given at the University of California on the evening of September 18, 1930.

been asked to outline its part in terms of modern science. Let me say at once that there was no thought of forecast in the beginnings of polar exploration. On the contrary, so far as the record permits us to learn, we see at first no other force in men's minds than that driving curiosity which is the motive power of most exploration everywhere and which impelled Pytheas of Massilia to the shores of Britain as it in like manner took Nansen to the inner Arctic where the secret of one part of the oceanographic puzzle might be found. Man insists on knowing what is in the outer world—the world outside the boundary posts of knowledge. Once it was discovered that such knowledge had utilitarian value, economics took a permanent place beside curiosity. "Scoresby Sound" in Eastern Greenland records a happy blend of business and curiosity on the part of that knight errant of Arctic exploration, Captain William Scoresby, who in thirty voyages to Greenland brought back rich cargoes of whale oil and even more valuable cargoes of geographical information from "a coast that was almost entirely unknown."

Exploration from earliest times to quite recent years began and ended in description of which the map was a kind of shorthand. Apart from adventure, the map told the story of what had been found: it enabled one to look at distant places "as if they were on the palm of your hand," to use the inscription employed in a Chinese atlas. To fill in the map has been one of the leading ambitions of explorers and will so remain until the last of earth's territory has been seen either by the eye or the camera, for if an electrically guided airplane and automatic camera should ever become feasible we may some day be able to map lands that no eye will have seen. When science had moved ahead to its modern position, exploration became a far richer enterprise. To-day it may be as varied as science itself. I remember receiving an inquiry from Professor Millikan for a lake in the Central Andes at the highest altitude which it was practicable to reach and of given size and depth, and fed principally by melting snow. So much of geographical requirement was laid down for the study of cosmic rays. The German Greenland Expedition has already experimented in ice-thickness measurements by echo soundings with an improved seismic device. Wilkins plans next year to explore the Arctic by submarine, his program including gravity determinations at sea and aerological work from the ice. Lars Christensen plans to have his captains make a census of Antarctic whales by airplane, the counting to be done from aloft in a single season possibly by the cooperation of several ships, each to take a sector of the waters off the south-polar continent if it should prove impossible for one vessel to make the circumnavigation.

It is natural in the face of all of these diversities of purpose, this extension of technology on a great scale to high latitudes, that the key to special types of forecast should also be sought in the polar regions. Man has learned that within certain narrow limits he can forecast a widening range of events in the physical world, and he finds that his new knowledge permits him to develop to increasing degree a more satisfactory "philosophy of the whole." It measurably satisfies man and it engrosses his interest to discover that there is an orderly scheme of things and that some of the workings and even the forecasts of such workings can become known to him. We are not surprised over the controversies of an earlier generation, and so recently even in our own, over questions of science and faith when we discover how lately science began to outline the physical universe and gain the power to forecast the effects of a few of the forces that are governed by law. It was not until just before the Revolutionary War that Franklin charted the approximate course of the Gulf Stream, and it was Franklin also who first traced the progress of cyclones. Ferell's law of behavior of the air in a cyclone was enunciated much less than a hundred years ago. The first self-recording instrument was taken into the Arctic (Parry) only a little more than a hundred years ago. The "polar front" or "squall line" theory with its important bearings upon the paths and character of cyclones, especially between Greenland and Norway, was outlined by Bjerknes only a few years ago.

There still remain in the world unexplored lands of total area at least twice that of the United States. The "Empty Quarter" of Arabia, lying almost within sight of the oldest routes of migration and trade in the world, measures 500 miles by 800 miles, and is therefore nearly a half million square miles in extent. So far as we can learn, no Western explorer has ever entered it. Though we weigh the stars and plot the courses of unseen planets we are yet without knowledge of much of the immediate world of mankind itself. We still live in the Age of Discovery, at whose threshold stood Herodotus and Prince Henry the Navigator and Eric the Red and Columbus. Indeed, if the men who made the Age of Discovery were to compare their lot with those of to-day they would vigorously assert that we, not they, live full within that age, for they would see an airplane flying upside down, human voices talking across ten thousand miles of space, an airship hitchhiking on the tail of a storm (*e.g.*, Eckener between the Sea of Okhotsk and Tokyo in his flight of August, 1929). However old the world may seem when judged by the record of the rocks, it is in an intellectual and

exploratory sense tremendously new—it is indeed as new as its newest idea!

The new ideas in polar exploration are not airplane and radio—these are but instruments of discovery. They are astonishingly reliable and useful instruments but they are of mechanical interest only, apart from the ideas they serve. Science feared for a time that they would run away with the game, because the popular mind is still on the romance of flying and the magic of communication by wireless. The really big game of the polar hunt are the scientific ideas or laws upon which the polar regions, and in some cases they alone, can throw light. Science is searching for particular things, not just anything. Real exploration has ceased to be a blind and adventurous wandering into the unknown. Take the contrast in present-day life and fossil remains at the two ends of the earth. The ring of land about the Arctic Basin has a mean summer temperature above freezing and the ground may thaw a few inches in a very few days. There are over four hundred flowering plants, some of them luxuriant. Past land connections have been sufficiently short and frequent to permit life migrations from continent to continent at least in the subarctic zone, with the result that it is possible to reach rather definite conclusions about the lands and seas of the past in the northern hemisphere and how things came to be as they are. No such definite conclusions can yet be drawn for the Antarctic. That region is still so great a mystery that were a fossil marsupial to be discovered there the event would excite some scientists probably as much as direct radio communication with Mars. I have mentioned marsupials because of the apparent need for a land bridge across Antarctica to account for certain similarities of structure between those of Patagonia and those of distant Australia.

Professor Scott is of the opinion that the most probable explanation of the origin of Australian marsupials is that a land connection existed at one time "by way of the Antarctic continent," a land connection that existed in early Tertiary times and by means of which the ancestors of the Australian marsupials migrated from South America. Others suggest that a point of origin in the Antarctic with migration on the one hand into Patagonia and on the other into Australia may be found to satisfy the facts of the case. In opposition is Matthew, who believes that the marsupials of these southern land masses were derived from northern ancestors. He relies upon parallel adaptations to explain the absence of a really close affinity between the forms under consideration. Anderson, on evidence more recent than that employed by Matthew, finds closer affinities between Australian and Patagonian forms than were known hitherto. However, he points to the conflict of evidence derived from a study of frogs, mollusca and plants. There is no positive evidence of the presence of marsupials in Australia before the Pliocene, and there is even an astonishing "paucity of pre-Pleistocene marsupial remains" in Australia. One of the major problems of animal migration is still in the stage of hypothesis for want of critical evidence that Antarctica may yet supply.

It is the meagerness of Antarctic life that makes wide-ranging speculation concerning the past history of Antarctica so difficult. There are but two flowering plants in the Antarctic, and these have a precarious hold at the extreme limit of their range. One is a grass; the other represents a family of herbs. Both are dwarfed. There are only the tiniest patches of tundra. No month has a mean temperature above freezing and the summers last but a few weeks. The search for fossils in Antarctica is to-day keener than ever because not only past but present distributions of life seem to find their explanation through them. In addition the search has already revealed that the life of Antarctica was once far more abundant. In the Jurassic period the whole earth enjoyed a climate milder than that of to-day. At that time there lived in West Antarctica the Sequoia, the Araucaria and the beech. With life so much scantier to-day we can see why Professor Gould, of Admiral Byrd's expedition, attached so much importance to the *earlier* record, however scantily revealed, in the carbonaceous sandstones from Mt. Fridtjof Nansen. Even the contents of the stomachs of seals and penguins have been searched for rock specimens, and thus much valuable information has been found about coastlines where no exposed rock exists. The dredge has brought up from the bottom of the Weddell Sea, from a depth of 10,000 feet, fragments of coral rock of Cambrian age; and the ice tongues that pour out through the western mountain passageways of the Ross Sea depression have borne from distant points limestone fragments of the same age that throw light upon past conditions. Mawson has just found that the erratics on the sea floor off Enderby Land are all continental in type, thus pointing to the unity of the new territory he has added to the map with the continental mass of Antarctica between Enderby Land and the Ross Sea. The fact is of special significance in tracing past life migrations and in building up sound concepts of life habitats.

It is the higher forms of life, however, that interest us most, for here we are closer to the background of man himself. Where we now have a highly specialized group of birds of which three are exclusively Antarctic species (the skua, the Adélie penguin and the emperor penguin) there was once a greater

variety. If we include fossil penguins of wider range the number of extinct species already known rises to twelve. It has been suggested that the diminished number of species and their higher specialization to-day were brought about by the advancing ice in a period of glaciation (not necessarily a colder period) even more extensive than the present one, for the ice at the present time has withdrawn from the wider limits it once claimed. If Antarctica to-day seems almost buried in ice, we can only say that in a still earlier period it was *overwhelmed*.

Among the leading objectives of all polar explorers of the past one hundred years are meteorological observations. In ever-increasing degree the polar explorer is besought by science to obtain exact records in increasing number in high latitudes. Less attention was paid to this feature of exploration in earlier years because the dynamics of the atmosphere were until recently so little known. Though Franklin had discovered the most significant feature of temperate-zone weather, it was many years before Ferell expressed the matter in dynamic terms. The first polar explorers could go only so far as the state of technology and theory permitted. The science of meteorology is a quite recent development. "Weather probabilities" were issued by Abbe at Cincinnati for the first time in 1869, and the first official weather forecasts were those of November and December, 1870. The word "probabilities" was displaced by "indications" in 1876, and the term "forecast" was adopted in April, 1889, only forty-one years ago.

The part that the polar regions had to play in the terrestrial wind system was only hinted at by the earliest observations, and theory took little account of the influence of great shifts of air from out of the polar regions to lower latitudes. In 1882–83 for the first time there was established through the work of the International Polar Conferences of Hamburg, Berne and St. Petersburg a chain of meteorological stations with the object of comparing simultaneous records at widely separated points. Eleven nations participated. Fourteen stations were occupied, three in the southern hemisphere. Following the first International Polar Year by an interval of two decades there were sent out a number of Antarctic expeditions in pursuance of plans discussed in outline at the International Geographical Congresses of London (1895) and Berlin (1899). Scott's first expedition represented the British, Bruce led the Scottish expedition, Nordenskjöld the Swedish, Drygalski the German and Charcot the French. The period 1901 to 1904 includes them all. A Belgian expedition had taken the field in 1898–99, and Charcot's second expedition operated in the period 1908 to 1910. These were animated, some in part only, others chiefly, by a desire to make comparable weather records at widely separated points about the border of the Antarctic.

The United States expedition to Lady Franklin Bay under the command of Lieutenant (now General) Greely, and an expedition to Point Barrow, Alaska, were the principal contributions of the United States to the first great international undertaking in the Arctic. Though more than a score of volumes have been published upon it, some of the results are still not completely worked up. It is argued by Henry that the first International Polar Year was held fifty years too soon. "There was left a gap between the polar stations and those of the middle latitudes entirely too wide to span by any sort of interpolation and thus the relation of polar weather to the weather of mid-latitudes failed of discovery." The daily weather charts constructed on the basis of the 1882–83 observations for a thirteen-month period revealed "a state of turmoil," as Sir Napier Shaw has expressed it, that "defies simplicity of description," and the formulation of laws of behavior of storms in the North Atlantic had to be deferred. The progress of cyclones and anticyclones across the Atlantic as revealed by these earlier studies was of little value in forecasting for western Europe.

But meteorological stations have been established in much greater numbers and much farther north in the interval of fifty years since the First International Polar Year. With the object of carrying out a more extensive program of observations (of possible value in future efforts to discover correlations between high and low latitude climatic conditions), there has been devised a program for a Second International Polar Year, 1932–33. An international committee of meteorological directors has taken the initiative in planning the position of stations and the precise nature of the observations on terrestrial magnetism, atmospheric electricity and meteorology, the observations to be carried through according to carefully devised techniques. In support of this proposal the American Geophysical Union has strongly endorsed the proposal that the United States government take a part in the establishment of certain stations and that the cooperation of private research organizations be solicited. Thus the National Research Council and the National Academy of Sciences will participate in what is believed will be one of the major scientific undertakings of the next few years.

The work of the Second International Polar Year and the meteorological observations of Arctic and Antarctic explorers in recent years are both inspired by a profound curiosity as to the suspected influence of weather conditions in high latitudes upon (or interaction with) those of the temperate regions as well as the tropics. The atmosphere is governed by phys-

ical laws and it is sought to discover the workings of those laws. We are here dealing with some of the greatest of the natural forces of the earth. To appreciate the magnitudes involved take the figures given by Shaw. He calculates that, subject to a correction of not more than 5 per cent. for air displaced by mountains, the mass of air in the northern hemisphere exceeds its mean value by over five billion tons in the month of January and falls short of its mean value by over five billion tons in July. This great shift of ten billion tons of air from hemisphere to hemisphere (timed to follow the curve of total power of solar radiation by twenty-seven days) is the equivalent of a mass of air thirty miles wide extending quite around the earth. So great a migration of air is not accomplished in a single simple movement, diagrammatically clear, mathematically precise, from point to point. There are many local variations, and there are also variations in time that appear when the figure is analyzed in detail.

Region by region it is the variations in the broad effects that are of concern to science seeking to learn the exact processes through which weather changes come about. Even the local or regional atmospheric displacements are represented by extraordinary magnitudes. The total energy of the motion of the winds of the earth has been calculated at "something near 20 billion horse-power-hours." Here we deal with figures that are akin to those of the astronomer, who deals with space, and the more we come to know of the atmosphere the larger the figures seem to become —in which respect at least we are gaining on the astronomer who, according to one of their high priests at a recent meeting of the American Astronomical Society, concluded that the astronomer must give up some of the territory over which he had extended claims of imperialistic magnitude!

A calculation of the forces involved in a single localized low-pressure area prepares one to believe that the polar regions include centers of action of astounding size and of direct interest and practical importance to mankind in the temperate zones. When the world was but thinly populated and wide spaces of excellent arable land awaited the settler we could afford to have little concern about the weather machine in its remoter manifestations of power. We see that in the historical development of our weather services. The Meteorological Office of Great Britain was established in 1854 "for the sea and navigation, not for the land and agriculture," and at its head was an admiral. The concern of Great Britain for meteorology grew out of the need for more precise information in making forecasts of value to ships and shipping. Our own weather service had its beginning in the United States Army in 1870. It was established primarily to serve agricultural interests. With the development of immense horticultural interests in the United States the need for precise forecasts has grown correspondingly. Plants that can not stand frost are grown up to the extreme limit of their range, the farmer demanding that science keep pace with him not merely in the selection of soil and seed but also in foretelling the weather.

Since the World War there has been a vast extension of settlement on the pioneer fringe of the habitable lands. Many thousands have gone into northern Canada, extending the edge of the plowed land far northward along a belt hundreds of miles in extent from the Rocky Mountains southeastward to the Laurentian Highland. In the past twenty-five years fifteen million Chinese have gone into Manchuria and hundreds of thousands of settlers are carrying the plow into the moister southeastern border of Mongolia. Pioneer development is in full swing in Southern and Northern Rhodesia and other parts of southern Africa. Australia has an immense territory of sun-baked land in which the marginal conditions of climate and settlement are maintained in delicate balance. We need not inquire at this time as to whether this immense thrust of modern civilization into land hitherto unoccupied is justified by an existing need of the world for additional food supplies. Despite the contention that in our machine age we do not need additional acreages of arable land, millions of settlers are still crowding the frontier. The pressure is not for more land but for cheap land that can not be found in the highly capitalized and overtaxed older communities. So long as people advance into the pioneer belts just so long must applied science follow them and attempt to ameliorate marginal conditions of living.

It is here that forecast should play a dominating rôle. Man does not ask the earth to be kinder to him; he asks only to be informed of its intentions that he may at least prepare for or deflect the effects of those great forces which he can not hope to neutralize or destroy. It happens that some of the pioneer land that remains in the world is on the poleward border of the so-called temperate zones, especially those of Canada, Siberia and Manchuria. Whatever connection may be found between polar or at least subpolar climates and those of the temperate zones will probably be of most direct benefit to the populations of the remaining pioneer lands which are still of great aggregate extent.

Once we knew the habit of the "spells" of Antarctic border weather we should be able to trace the connection, if such exists, between them and the rainy and dry periods in the cereal and pastoral lands of Australia, South Africa and Argentina. It is under

the impulse of this idea that Captain Sir Hubert Wilkins has carried on his explorations in the Antarctic Archipelago for two seasons. He did not go down there just for fun; he has been searching for suitable bases for meteorological stations to be established by international cooperation. With a ring of such stations about the Antarctic, and with daily weather reports from them by radio, it may be possible to draw charts that trace the effects of cyclones and anticyclones as they move forward from breeding places out over the southern ocean. The problem is in no sense one that will be solved in a simple manner. Correlation is the basis of forecast and the laws of correlation can only be developed after an observational basis has been established.

To forecast seasons of drought in the lands of the southern hemisphere would be a practical achievement of the highest order, and no less important would it be to forecast seasons of exceptional rain. We have in Australia, Argentina and South Africa great areas of marginal lands where for several years on end it may be too dry to maintain flocks and herds and crops of normal extent. Even in years of sufficient rain the farmer needs notice of the event to enable him to take advantage of nature's bounty. It is not putting the case too strongly to say that the practical benefits to southern lands of meteorological studies in the Antarctic through the medium of a chain of weather stations outweigh all other Antarctic interests, of a material sort, put together.

Through a series of field expeditions in Greenland, Professor W. H. Hobbs has confirmed the theory of slope effect and revealed Greenland as one of the important centers of action in the Arctic on a scale smaller than similar centers in the Antarctic but quite as important in effect for large portions of northwestern Europe. Combining the flight observations of Captain Sir Hubert Wilkins and those of the Norwegian weather charts, Sir Napier Shaw has traced the march of a "cold front" from Greenland to the Norwegian coast from April 14 to 16, 1928, and has outlined the dynamics of the process of the flowage of air from Greenland "to take part in the formation of snow and rain about Spitsbergen." Southern Greenland, like the Aleutian Islands, appears to be a special center of conflict between polar and equatorial air and therefore among the most critical localities on the border of the Arctic region for the study of interchanges between these two great climatic belts.

The former director of the Dominion Meteorological Service of Canada, Sir Frederic Stupart (and others), has pointed to a persistent stream of low-pressure areas approaching the northeastern coasts of Canada and Alaska from the Pacific and passing into and perhaps across the continent of North America, while another stream passes from the Gulf of St. Lawrence eastward past southern Greenland and northwestern Scandinavia, with the polar regions lying between these two great streams. He points to the variations in atmospheric circulation caused by the difference in habit from season to season of the cyclonic areas that form in the Pacific and which move into America sometimes abnormally far toward the north, sometimes abnormally far toward the south. Science can not yet state either the dynamics of the case or the causes that lie back of these major changes, but it seeks light on the question in both high and low latitudes. It is not content with its present position in the matter. Its object is forecast as well as explanation. The two are the right and left hands of the argument. To see so far and yet not see farther, to know so many things about the atmosphere and yet be unable to forecast the major changes that produce profound effects upon the climate of inhabited regions—these are the things that challenge the ingenuity of the physical scientist and that inspire his curiosity as to the exact conditions to be found across the threshold of the Arctic.

Playing a part in the great meteorological set-up of the world is the habit of the ice both north and south. Krümmel estimates the volume of the drift ice which reaches the Atlantic Ocean yearly from the North Polar region at 20,000 cubic kilometers. An estimate of 30,000 cubic kilometers has been made for the Antarctic, or 50,000 cubic kilometers in all. This represents a column of ice with a base larger than twelve city blocks (1,400,000 square feet) and reaching out into space as far as the moon. If evenly distributed it would cover the entire land surface of the earth with a layer of ice a foot thick! These are of the first order of geographical magnitudes and their mere statement is enough to show why significance is attached to the meteorological relations of polar ice discharge. But this is not all. The ice discharge is subject to very great variations from year to year. Commander Smith reported about 1,200 icebergs south of Newfoundland in 1912, while in 1924 the total was only eleven! Taylor has described Antarctica as "a fluctuating refrigerator" on a colossal scale. In calmer periods ice gathers; in stormy periods it dissipates with wide effects because low-pressure areas "whose northern portions" bring precious winter rains to the nearest tips of the southern continents "move mostly over far southern waters."

The English meteorologist, Brooks, has made a statistical investigation of the influence of the Arctic ice on the pressure distribution of western Europe. From a study of ice conditions in spring and summer in a part of the Arctic made known to us from annual

surveys of ice conditions by the Danish Meteorological Institute it has been sought to discover relationships between the quantity and the position of the ice and the pressure of the atmosphere at selected stations in Greenland, Norway and elsewhere. It has been found that when there is much ice in the Arctic definite increases of atmospheric pressure may be discerned in spring and summer at some stations and a diminished pressure at others. The pressure of the late autumn and winter is below normal over the British Isles and northern France when there is much ice in the Arctic. Similar effects tend to recur annually at northern stations for about three years following abnormal ice years. It must not be supposed from this statement of relationships that the matter is quite as simple as the phraseology would suggest. It has been found that the influence varies with the season and thus appears to be due to a combination of several factors, some acting in one direction, some in another. The "correlation coefficients," as the scientist calls them, are never high, but they are regarded by Brooks as being appreciable at times, and he concludes that they represent realities. Some of the Arctic ice correlations are more immediately useful. Commander Smith, of the International Ice Patrol, has described a method of ice forecasting that has been employed with "a high degree of success."

Certain ice and weather correlations were noted many years ago and again more recently by Dr. Otto Pettersson. Between 1892 and 1897 there was "an enormous outburst of ice from the Antarctic which filled the Southern Ocean with ice floes and icebergs to such an extent that traffic between South America, Africa and Australia had to seek a more northerly track." In Pettersson's view this outburst had far-reaching climatic repercussions. The monsoon region of the Indian Ocean was profoundly disturbed. Years of excessive rainfall (1893 and 1894) were succeeded by years of drought (1896 and 1899) followed by wide-spread famine. The loss of cattle ran into the millions. Australia also suffered. In New South Wales and Queensland almost continuous drought prevailed from 1896 to 1902. In these seven years it is estimated that there were lost over fifty million sheep at a value of over sixty million dollars. Ice dangerous to navigation was again reported in relatively low southern latitudes in 1922. The Humboldt Current was deflected westward early in 1925, and warm coastal waters running southward between the Humboldt Current and the Peruvian Coast brought an abnormal rainfall along the arid western border of Ecuador, Peru and Chile, with destructive effects upon plantations and houses, irrigation canals and ports and towns unaccustomed to the rain which comes only at intervals of several or many years. Whatever the relationships between the argument and the observational basis of Pettersson, it can hardly be supposed that the changes that take place on so colossal a scale in the movement of ice out of the Arctic Sea and off the Antarctic Continent and northward from surrounding waters are without their climatic effects.

Commander Smith, of the Ice Patrol, has found bottom water in the trough between Greenland and Labrador of such low temperature (2.6° C.) and high salinity (34.90) as to point to an Antarctic origin, which means a slow creep northward over the intervening 10,000 miles of distance. But until the scattered reports of ice conditions, current flow and climatic changes (now gathered largely at haphazard) are brought into some systematic relation, or, better still, until sustained and cooperative observation has taken the place of scattered and uncontrolled observation, we shall be without that specific information upon which alone can be based an outline of the dynamic relation between the ice discharges of high latitudes and the climates of the poleward margin of the northern and southern temperate zones. The study of the ice on the one hand and of the habits of the migratory high and low pressure areas on the other are two of the major interests of science in polar exploration to-day.

We can not hope that long-range weather forecasts will do more than show the direction which a predicted change will take, that is, that the year or years ahead will *tend* to be drier or wetter as measured by an average year. One has only to see Biel's recent world map showing the variability of the annual rainfall from region to region to observe that prediction can not be based upon a single sweeping law. So far as we can see at the present time it is only by the patient fitting together of at least the critical parts of existing records and those yet to be gathered in selected places that a substantial basis of forecast may be found. The variability of rainfall expressed on Biel's map runs from less than 10 to more than 40 per cent., and the zones of given variabilities are in general of most irregular pattern. It is significant that the only seasonal forecasts now attempted by government are in tropical regions where the meteorological conditions are fairly constant as compared with those of higher latitudes. They are the forecasts for India made by the Indian Meteorological Department, and those for Java made at the Batavia observatory. This lends added interest to meteorological studies in the polar regions, since one may hazard the guess that whatever basis of forecast may be found practicable in the tropics and temperate zones the forecasts for the higher latitudes of northern North America and northern Europe as well as those of South Africa and Argentina will be found to depend upon conditions

that are at least influenced by what happens in polar centers of action.

This is getting a long way from the empirical studies (useful as they have been) that marked the first steps in the direction of forecast. It is also a quite different thing from the deductions and partial correlations based on a study of astronomical cycles or upon the simple supposition that because the climatic changes of the past have had a certain recognizable periodicity such periodicities will be repeated more or less regularly in the future.

One can hardly appreciate the value which the scientist attaches to meteorological observations in the polar regions if he supposes that physical science advances by precise laboratory methods alone. At the present time some of the leaders in the social sciences are striving to discover something akin to the precise techniques and exact measurements of the physical sciences in order that human behavior may be "scientifically" studied. There is danger that such a point of view may overlook a difficulty of the physical sciences that is clouded by the striking fact that it has so many precise results. I refer to "field relations." One may experiment with air in a laboratory or with a crystal or with an electric current or with a lens and obtain certain precise values. But in many if not in most cases this is not the object of the scientist who conducts the experiment. His ultimate objective is not merely the thing before him but the law involved; and once he has discovered the law he attempts to apply it to the field. Here is where he is confronted with quite special difficulties because the field is almost infinitely complex if he deals with anything more than broad generalities. To a large degree "the wind bloweth where it listeth," in spite of the laws of dynamic meteorology. There is a topography to be taken into account and a host of complicating conditions of land and sea and ice, earth's rotation and water vapor and changes in solar radiation.

To the complications of nature are added those of observation and record and the assembly of an infinity of figures. The meteorologist is obliged to use observations "which can never be repeated and which have been made by some one else" (Shaw). In forecast it is still true that no dependable sequence of events has been worked out except locally, as in India and Java. To this number should be added the rainfall predictions of the Scripps Institution of Oceanography, which by a study of the temperature of the adjacent sea has been able to predict the rainfall of parts of the Southwest (U. S.) "with encouraging accuracy" (nine successful forecasts in twelve years). There are suggestions of other correlations, as, for instance, those of Commander Smith, who seems to find in the recent temporary amelioration of Arctic climate some relation to what he calls a "heat reservoir of tremendous proportions," namely, a surface layer in the North Atlantic over 300 feet in thickness covering an ocean area 100,000 square miles in extent and showing a temperature five degrees higher than normal.

There are many events for which we need no forecast if we once know what the facts really are. We happen to know accurately enough the history of the Nile floods for 960 years, and we know that only four times in that millennium has the river been as low as it was in 1913–14. Merely to know that fact is to know of the negligibly small chance of an extremely low Nile within a limited period of years in the immediate future. Facts and more facts of this character are what has given man his mastery over the earth to a large degree—he has seized facts and at least here and there directed his destiny to a desired end. If we are ever accurately to state the events that precede, accompany and follow important changes in ocean currents, as, for example, off the Peruvian coast in 1925, we shall have to make studies of far wider scope and seek correlations of which at the present time we have in most cases no hint.

Once we have carried our thinking to this point we see the great importance of an expedition like that which Captain Sir Hubert Wilkins and Lincoln Ellsworth are proposing to take into the Arctic in the summer of 1931. On a route 2,200 miles long from Spitsbergen to Alaska they propose to make life studies, take gravity measurements, secure bottom samples, observe the conditions of terrestrial magnetism and study the currents, the ice and especially the temperature and salinity of the sea water, as well as take soundings by the echo depth sounding device and wherever possible send up balloons equipped with meteorological instruments that will reveal the condition of the upper air. That these studies are to be made in a submarine seems at first wholly fantastic. But no one who has studied the plans in detail can fail to be impressed with the practicability of the scheme, for it is based upon a thorough knowledge, on the part of the leaders, of ice conditions across the entire Arctic Basin. Captain Wilkins's flight of April, 1928, equipped him to study the surface ice from the standpoint of submarine navigation, and along a different path Ellsworth was able to observe the character of summer ice.

The layman might suppose from the definite conclusions which science has reached here and there or from the definite objectives which it sets up in every field that we should presently come to the end of things. Here and there one hears the phrase "when science has gone as far as it can" or "when we have learned all that there is to know." If such were indeed the case we should need to be in no hurry

about the attainment of the end. Polar exploration, like all other forms of exploration or of creative thinking, could well afford to take its time. We might even go so far as to consider the suggestion that has come to us from the social sciences (none too seriously made, of course) that there should be declared a moratorium in the physical sciences. As a matter of fact, science can not be restricted by quotas. We can never declare a moratorium on curiosity. We can never know too much about this amazing universe unless we are to suppose that ultimate knowledge is evil. All that science has done up to the present is to provide glimpses into what we call the natural world. Each advance supplies a fresh incentive for further research. Each discovery is a springboard from which another jump is made into the unknown. Recently the head of an American institution announced that there had been "solved the problem of the Southwest." Apart from the fact that there is no one problem of the Southwest, the "Southwest" is hardly a thing to be solved! In making a proposal for a given study its sponsor remarked to me recently, "Let's get this thing settled once for all." He was dealing with a matter involving such variables as winds and ocean currents and the migrations of people of whom we have but the most fragmentary records.

The scientist does not seek the end of things in the sense of these two quotations. He is trying to discern the process, to discover the law. He does not say, "Here we are at last!" but "Where next?" This is the real spirit of discovery. It is true that we are able to express magnitudes so great that formulas have to be devised if the figures are not to escape human comprehension. It is true that we have girdled the earth with human speech, provided a partial post-glacial chronology accurate almost to within a year, and measured the depths of the sea with a sound wave. But it is also true that we have not yet discovered a way to stop the scourge of cancer, that we have not provided mankind with a reliable long-range forecast of the weather however much we may know of the physics of the air, nor have we been able to put the vagrant energies of tides and winds to the service of the steadier purposes of mankind.

We have not been able to do these things and many others because the statesmanship of science is not equal to the task of developing the techniques of science fast enough to keep pace with our needs, or if techniques are developed we are not able to discern as rapidly as we should the wider unities without which technology has no meaning. From an enormous mass of facts science must comb out the accidental and discover that which has significance, that which is recurrent, that which seems to relate cause and effect. Polar exploration is no exception to this rule. The literature of the subject is filled with romance and adventure, with casual happenings. Thousands of pages are filled with wholly irrelevant details, from the scientific standpoint. Those who work upon the creative fringe of the sciences that are served by polar exploration must read far to find a little. Partly this is due to the fact that youth and leadership are required to face the hard conditions of Arctic and Antarctic living. The first essential, before the maturities of science are given a chance, is to get in and out safely or at least with reasonable chance of security. Hard work and great risks are the rule. This means that we can not put romance out of the business. We like to personalize expeditions and events, to build up a hero. The heavy financial requirements can be met apparently only through agencies that demand news, and polar news is largely polar adventure. Nor is it adventure to the layman only. The scientist himself is conscious of the unknown about him. And who can escape the sense of mystery that pervades the unknown? Under such circumstances one can not wish to set metes and bounds to the imagination.

There is a wider sense in which we need exploration of the ends of the earth and why curiosity drives men into the unknown places. From the philosophy with which science was at first closely associated it long inherited the concept of "system," and the need for text-books tended to cause still further devotion to system. The creative fringe of scientific thought is often lost sight of in the too rigid formulation of law. Men have escaped the pain of thinking by inventing words that defeat the spirit of curiosity. To take a familiar example, we have in science the word "anomaly." If a thing does not fit into the regularities of the accepted system it is labeled "abnormal" or at least "anomalous." So far as the earth sciences are concerned I should say that it is a distinctive feature of their development in the last twenty-five years that inquiry is largely directed to the investigation of the anomalous occurrence, for is not the anomalous occurrence itself obedient to law? The lexicographer defines the word *anomalous* as "exceptional" or "unusual." When he goes on to term it "irregular" we do not follow him. When the Humboldt Current is displaced by the warm water creeping out of the Gulf of Guayaquil and down the coast of Peru at intervals of years we look upon this commonly well-behaved stream as exhibiting an anomalous course and the popular mind regards the occurrence as freakish. But science concentrates upon the anomalous behavior of the Humboldt Current and sees that the unusual behavior of that stream has a certain regularity if not perhaps a periodicity. We have hints that its deflection is an annual occurrence and what we have

termed "anomalous" in it becomes only an expression of degree. From many such occurrences the scientist takes a fresh view of his world of nature and at last begins to wonder whether the anomalies of that nature are not of more critical importance than the generalized systems that include only so-called "normal" occurrences.

We are all aware that the physical processes that control our weather are not uniform in their behavior. Aside from the purely accidental there are certain long-range changes in meteorological conditions. From time to time we are brought to a full realization of a long-range increase or decrease of rainfall by their calamitous effects—the starvation of millions in Russia and India or the disastrous losses in the live stock industry in South Africa and Australia. The drought in the United States during this past summer startles us into a realization that nature now and then seems to defy its own mode.

In the search for the causes of these unusual or anomalous changes the widest comparisons have been made of climatic conditions in different parts of the world. The records of thousands of stations have been scrutinized. In the United States a preliminary examination of the records shows that "the occurrence of wet and dry years seems to be wholly fortuitous." The most we can say is that there appears to be a general tendency toward years of lean rainfall, with years of greater rainfall making their appearance only when there is "an extraordinary disturbance in one or more of the dominant members of the atmospheric circulation" (Henry). Different parts of the country seem to have their return of wet or dry years with great variation, so that the probability of heavy rains becomes less the greater the area involved. This is a most striking conclusion for a territory so large as the United States, but its significance seems to be diminished by certain comparisons made in more recent years in which highly significant "correlations" seem to have been discovered in places far apart. Thus Darwin in Northern Australia occupies "a position of singular importance in world meteorology" (Quayle). Its air pressure records have proved valuable in forecasting Indian weather and striking correlations seem to appear in the comparison of its weather records with those of many other, chiefly tropical, stations. The Argentine Meteorological Office for a number of years made eight-day forecasts of the weather based in part upon the measurement of the intensity of solar radiation at Calama, Chile, nearly a thousand miles away. A remarkable correlation (coefficient of .88, 1 representing complete proportionality of change) has been discovered between the mean annual level of Lake Nyanza in Africa and sun-spot occurrences.

The discovery of the apparently critical relation of weather conditions at a few given stations to the weather changes at quite distant points adds greatly to the significance of studies in polar meteorology. Unusual localization of meteorological forces has been detected in both the Arctic and the Antarctic. Now it is hardly conceivable that such a habit of localization could continue without correspondingly specific (and in time, we hope, measurable) effects within adjacent areas of wide extent. But the study of localizations is not enough. We have to take account of all the air there is, not of a part of it. There is no reason to suppose that the wide-reaching correlations of lower latitudes may not find their counterpart in high latitudes. Thus the scientist seeks not merely the habit of the weather (or, in more general terms, the characteristics of the climate) of polar regions. He conceives himself as eventually discovering correlations between polar centers of action and those of lower latitudes. Where those key stations may be no one can guess, for the key stations that have been already discovered are far from being explained.

I must at least mention the importance of polar exploration to aviation, especially in view of the service that the airplane has rendered to Arctic and Antarctic expeditions of the past five years. You are familiar with the idea of a trans-Arctic route between Europe and the Far East so long advocated by Stefansson. The idea rests fundamentally upon the stability of meteorological conditions within the Arctic Basin from October to May. No one who has any doubt about that stability could fail to have it dispelled by reading De Long's account of the remarkable uniformity of the weather in the winter that he spent on the *Jeannette* during her drift into the Arctic Sea north of Siberia. But probably long before such flights become practicable we shall have shorter flights from point to point along the fringe of the Arctic. The British Arctic Air Route Expedition is seeking light on controlling local conditions at the present time in Greenland. The "stepping-stone route," as it has been called (Joerg), passes by way of the Faeroes and Iceland to Greenland and Labrador, thus restoring in the air the counterpart of the sea-way that was first pioneered by the Norsemen. We have at last entered the stage forecast by Leonardo da Vinci, who saw no reason why man should not become "lord of the winds and rise conqueror of space."

In so far as sea navigation shall become possible the high latitudes offer many advantages of shortened distances and natural stepping-stones, with man feeling safer, in the present condition of flight technology, in the knowledge that land is beneath him at intervals on the way. In weather forecasting the setting up of

a line of meteorological stations along aviation routes would seem to be a first condition. There must also be a much wider coordination of the observations at stations already established. Finally, both the new and the old stations can not be grouped by countries, as in the past, but must be tied in with the airports at the ends of the routes as well as at points between, wherever they may fall with respect to international boundaries. It thus appears that aviation has its own special requirements. We see that clearly in air pioneering in the United States, where the habit of the weather is fairly well known from region to region. How much more important it becomes in high latitudes of the northern hemisphere where successful flights have already been made by airships and airplane around the earth!

[Following his paper Dr. Bowman showed about sixty slides arranged in eight groups as follows: (1) a map of world rainfall variability in relation to pioneer belts to show the importance to future settlement in relatively high latitudes of strong rainfall variations; (2) the position of high-latitude meteorological stations in the northern hemisphere and the paths of high-latitude low- and high-pressure areas that have weather effects in lower latitudes; (3) types of ice and the conditions of ice discharge in the Arctic and the Antarctic; (4) dynamic conditions in the Arctic and the Antarctic in relation to currents, and land and sea migrations of the present and of past time; (5) economic conditions related to the whaling industry and questions of sovereignty; (6) radio exchanges between New York and the field expeditions of Byrd and Wilkins to illustrate the possibilities of scientific consultation while work is actually in progress; (7) the routes and relations of the four main Antarctic expeditions of the past year; (8) physiographic features, especially in the Antarctic Archipelago.]

OBITUARY

GEORGE FOUCHÉ FREEMAN

1878–1930

DR. GEORGE F. FREEMAN, director of the Federal Experiment Station at Mayaguez, Porto Rico, since April, died suddenly on September 18. Interment was made at Manhattan, Kansas.

Dr. Freeman was born at Maple Grove, Alabama, on November 4, 1876, and was graduated from the Alabama Polytechnic Institute at Auburn, Alabama, in 1903. He was granted the degree of doctor of science by Harvard University in 1917. He began his career as a botanist, but became a plant geneticist and educational administrator. He was a member of the botanical staff of the Massachusetts Agricultural College during 1903, and of the Kansas State Agricultural College from 1904 to 1909. From 1909 to 1918 he was in charge of plant-breeding work at the Arizona Experiment Station. In 1919 he was called to Egypt by the Egyptian government to organize the cotton breeding work for the Sultanic Agricultural Society, where he remained three years, at which time he returned to the United States to accept a similar position with the Texas Agricultural Experiment Station. He remained in Texas for a year and was then appointed to an agricultural commission to Indo China by the French government, which work required a year. Upon his return to the United States he was nominated, by the President of the United States, director general of the Service Technique of Haiti, where he went in 1923 to build up a vocational educational system and an agricultural development program. He remained in Haiti until April, 1930, when he resigned to become director of the Federal Experiment Station at Mayaguez, Porto Rico, at which place he resided until death overtook him.

Dr. Freeman's scientific activities centered primarily around cotton. He gave considerable attention to a study of the various varieties of cotton and had made substantial progress on a monograph of the cottons of the world.

He did his greatest work, however, in Haiti, as an administrator and organizer of the Service Technique. He built up an organization of 476 employees in six years, of which 91.6 per cent. were Haitian, according to the "Annual Report of the Service Technique for 1928–1929."[1] The property valuation, which included school building, school land and school equipment, amounted to $1,475,000. A total of 11,430 pupils and students were being accommodated. While this represents a mere beginning towards reducing the estimated 85 per cent. illiteracy in the country and in building up a nation undeveloped both in agriculture and along industrial lines, it indicates something of the enthusiasm and energy with which this difficult task was undertaken. Dr. Freeman deserves the lasting gratitude of the Haitian people for what he accomplished. The complete realization of the program can not be expected before two or three generations.

Dr. Freeman was the author of numerous reports and scientific contributions. He was a member of sev-

[1] Annual Report, Technical Service of the Department of Agriculture and Professional Education, Port-au-Prince, Haiti, Bul. No. 17. 1929.

eral leading scientific societies and was widely known among scientists and educators.

ROGER C. SMITH
KANSAS STATE AGRICULTURAL COLLEGE,
MANHATTAN, KANSAS

RECENT DEATHS

ERNEST HENRY WILSON, keeper of the Arnold Arboretum of Harvard University, and Mrs. Wilson were killed in a motor accident in Worcester on October 1. Dr. Wilson was fifty-four years old. He had been connected with the arboretum since 1906.

EDWARD FOSTER, state entomologist for Louisiana, died on October 8.

HENRY MARTYN MACKAY, dean of the faculty of applied science and professor of civil engineering at McGill University, died on October 25 in his sixty-third year. He had been associated with the university for twenty-six years and had been head of the faculty of applied science since 1924.

PAUL E. APPELL, professor of mathematics at the University of Paris, member of the Institute of France, died at Paris on October 24. He was seventy-five years old.

SIR FRANCIS WATTS, K.C.M.G., first principal of the Imperial College of Tropical Agriculture at Trinidad, died on September 26, aged seventy years.

LORD BROTHERTON, first baron of Wakefield, has died at the age of seventy-four years. He was the founder of extensive chemical manufacturing plants throughout England and Scotland. In June of this year he was awarded the Messel Medal by the Society of Chemical Industry for his services to the industry.

MEMORIALS

THE Northeastern Section of the American Chemical Society has announced the establishment of a gold medal to commemorate the fundamental contributions made to chemistry by the late Theodore William Richards, who at the time of his death was Erving professor of chemistry at Harvard University and director of the Wolcott Gibbs Memorial Laboratory. The medal, which will be awarded at intervals of two or three years for achievements in chemistry, is being designed by Cyrus E. Dallin, a sculptor who was an intimate friend of Professor Richards. An opportunity is offered the friends of Professor Richards to assist in securing the sum of $10,000 which is required to cover the initial expenses and provide a trust fund yielding sufficient income for the successive medals and incidental expenses.

CONTRIBUTIONS are invited to the Joseph W. Richards fund by the American Electro-chemical Society. The fund was inaugurated by the board of directors, in order that an independent income might be available to be used towards the payment of expenses of invited speakers from Europe or elsewhere. The plan of the fund embodies the wish that the late Professor Richards so often expressed during the many years of his untiring service as secretary of the society. Contributions should be sent to the secretary, Dr. Colin G. Fink, Columbia University, New York City.

THE new observatory on the Rechenberg, near Nüremberg, Germany, has been completed in time for the celebration of the three-hundredth anniversary of the death of Johannes Kepler. In connection with this event there will be an exhibition of objects connected with his life and work.

SCIENTIFIC EVENTS

THE CENTENARY OF THE ROYAL GEOGRAPHICAL SOCIETY

ACCORDING to the London *Times* the Royal Geographical Society celebrated its centenary on October 21 and 22. Since the society was founded 100 years ago under the patronage of King William IV its work has been followed with interest by successive Sovereigns and members of the Royal Family. The Duke of York, representing the King, who is patron of the society, inaugurated the centenary celebrations, and the Prince of Wales, vice-patron of the society, presided at the centenary dinner. The occasion was noteworthy as marking the use, for the first time, of the lecture theater and library, which have been added to the society's house. There were present at the various ceremonies in connection with the centenary representatives of the principal geographical societies throughout the world and delegates from many other scientific institutions.

On the afternoon of October 21, the Duke of York, representing the King, received fellows of the society and delegates from other bodies in the new hall which seats 850 people. The delegates of the Société de Géographie of Paris and of the Gesellschaft für Erdkunde of Berlin—societies which have already celebrated their centenaries—read addresses. The new buildings of the society were then declared open. On Tuesday evening the society held its centenary meeting in the new hall, when Sir Charles Close, the president, Mr. Douglas Freshfield, Sir Francis Younghusband and the Marquess of Zetland, past presidents, and Dr. H. R. Mill, vice-president, spoke on the history of the society.

On October 22 a series of short papers on "The

Habitable Globe" was read at a morning meeting by eminent British and foreign geographers. In the evening the president, council and fellows of the society entertained the delegates and official guests at a reception in the society's house. A further series of papers on "The Habitable Globe" was read on the morning of October 23, and in the afternoon papers on "Incidents in the History of Exploration" were read by Lord Lugard, Sir Francis Younghusband, Sir Halford Mackinder, Lieutenant-Colonel F. M. Bailey, Mr. J. M. Wordie and other British explorers. The centenary dinner of the society was held in the evening at the Connaught Rooms, when the Prince of Wales presided.

The following is a list of foreign geographical societies, in the order of their foundation, which were represented at the centenary celebrations:

Société de Géographie, Paris (1821); Gesellschaft für Erdkunde, Berlin (1828); Verein für Geographie und Statistik, Frankfurt (1836); Instituto Histórico e Geográfico Brasileiro, Rio de Janeiro (1838); Sociedad Mexicana de Geografía y Estadística, Mexico City (1839); Gosudarstvennoe Russkoe Geograficheskoe Obshchestvo, Leningrad (1845); American Geographical Society, New York City (1852); Geographische Gesellschaft, Vienna (1856); Société de Géographie, Geneva (1858); Reale Società Geografica Italiana, Rome (1867); Geographische Gesellschaft, Munich (1869); Magyar Földrajzi Társaság, Budapest (1872); Sociedade de Geografia, Lisbon (1873); Geographische Gesellschaft, Berne (1873); Nederlandsch Aardrijkskundig Genootschap, Amsterdam (1873); Société de Géographie Commerciale, Paris (1873); Geographische Gesellschaft, Hamburg (1873); Societatea Regală Română de Geografie, Bucharest (1875); Real Sociedad Geográfica, Madrid (1876); Société Royale Belge de Géographie, Antwerp (1876); Svenska Sällskapet for Geografiske Selskab, Copenhagen (1876); Société Royale de Géographie, Antwerp (1876); Svenska Sällskapet for Antropologi och Geografi, Stockholm (1877); National Geographic Society, Washington (1888); Sociedad Geográfica, Lima (1888); Norske Geografiske Selskab, Oslo (1889); Sociedad Geográfica, La Paz (1889); Chicago Geographical Society (1894); Association of American Geographers, Nashville (1904); Geografsko Društvo, Belgrade (1910); Sociedad Chilena de Historia y Geografía, Santiago (1911); Polskie Towarzystwo Geograficzne, Warsaw (1917); Association de Géographes Français, Paris (1920); Instituto Coloniale Fascista, Rome (1927), and the Chinese Geographical Society.

THE LANGUAGES OF AMERICAN INDIANS

THE Twenty-fourth International Americanist Congress which met at Hamburg from September 7 to 13 passed the following resolution:

The rapid settlement of America and the progress of assimilation of the natives, as well as the decrease of the population of many tribes bring it about that the languages of the American Indians are rapidly disappearing. On account of their great divergence in structure the Indian languages form one of the most important objects of study for the science of language. Our generation is the last one that is able to collect this material and it is our duty to study the native languages energetically and to preserve these valuable treasures for future times.

Three years ago the Carnegie Corporation, at the instance of the Council of Learned Societies, appropriated funds mainly for the study of North American languages. In some parts of Mexico, Central America and South America the investigations are even more urgently needed than in North America. Notwithstanding the efforts of missionaries many languages are entirely unknown. Of others we have only vocabularies, inadequate grammatical sketches and religious treatises. Modern researches must be based on collections of texts dictated by native speakers, not on translations.

In consideration of these facts the Twenty-fourth International Congress of Americanists meeting at Hamburg has passed the following resolution which is to be transmitted to the Council of Learned Societies:

The Twenty-fourth International Congress of Americanists meeting at Hamburg considers the thorough study of the vanishing native languages of North America, Mexico, Central America and South America one of the most urgent demands of science. The congress expresses its gratitude to the Council of Learned Societies for its active support of these researches and urgently recommends to the council the continuation of its efforts and hopes that it will see to it that the study be extended over the whole continent of America.

Furthermore the congress has passed the following resolution to be transmitted to the Carnegie Corporation: The Twenty-fourth International Congress of Americanists expresses its gratitude to the Carnegie Corporation for their liberal support of inquiries intended to save the vanishing native languages of America. The congress expresses the hope that the undertaking begun with the support of the Carnegie Corporation may lead to a thorough investigation of the languages of the whole American continent.

The congress instructs the delegates of the American governments and institutions to communicate these resolutions to the governments and organizations represented by them.

RECOMMENDATIONS OF THE ADVISORY COMMITTEE ON EDUCATION BY RADIO

THE Advisory Committee on Education by Radio, which was appointed by the Secretary of the Interior, has presented a report signed by William J. Cooper, commissioner of education. The recommendations as contained in the report follow:

1. That there be established in the Office of Education, Department of the Interior, a section devoted to education by radio, and charged with such responsibilities as

the following: (a) To receive from the advisory committee on education by radio its files and collected documents, to keep this material up to date and available for reference by the many students of the subject; (b) to organize some of the material into bulletins to be issued as demand warrants; (c) to outline techniques for research and carry on investigations into the best methods of broadcasting and compare the results of lessons sent to schools by radio with the results obtained by other means; (d) to keep the educational interests of the country fully posted on and alive to the importance of this new instrument as an educational tool; (e) to attempt to prevent conflicts and duplication of effort between various broadcasting interests; (f) to furnish advice on the educational soundness of programs suggested and to supply typical programs upon the request of any station whether educational or commercial.

2. That the funds necessary for financing such a section in the Office of Education be provided in the regular budget for the Department of the Interior.

3. That there be set up in connection with this unit an advisory committee representing educational institutions of commercial broadcasters and the general public. This committee should consist of 9 to 15 persons whose residence is such that they can meet from time to time for actual consideration of problems arising in the Office of Education. This committee may well administer any funds remaining in our budget to promote research into the techniques of radio education.

4. That an effort be made to secure from interested persons or foundations an amount of money sufficient to bring to the microphone, for a period of two to three years, a high grade program in certain formal school subjects and to check carefully the results obtained. The committee believes that as much as $200,000 per year for a period of three years may be wisely expended in this manner, under direction of a non-partisan committee of educators and laymen.

5. That the secretary bring to the attention of the Federal Radio Commission the importance of the educational interests in broadcasting, and that he keep the President of the United States informed of the desirability of having on this commission spokesmen for programs which will tend to improve the general well-being of the American people.

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

AT its meeting in October the National Research Council's Committee on Grants-in-Aid made the following eleven awards:

Arthur A. Bless, associate professor of physics, University of Florida, for a study of diffraction of X-rays by polar molecules subjected to high steady and alternating fields; Perley A. Ross, professor of physics, Stanford University, for study of the width, intensity and structure of the modified line in the Compton effect.

E. M. Kindle, chief, division of paleontology, Geological Survey of Canada, Department of Mines, Ottawa, for a study of criteria for the correlation of Devonian formations; Chester K. Wentworth, associate professor of geology, Washington University, for comparison of glaciated and river-worn cobble stones.

L. R. Cerecedo, assistant professor of biochemistry, University of California at Berkeley, for investigations on the purine fraction of the nucleic acid molecule; Harry J. Deuel, Jr., professor of biochemistry, University of Southern California Medical School, for a study of the relative antiketogenic value of various carbohydrates; Ernest W. Goodpasture, professor of pathology, Vanderbilt University Medical School, for investigations on the etiology of *Granuloma inguinale;* Reginald D. Manwell, assistant professor of zoology, Syracuse University, for a study of avian malaria.

F. E. Chidester, professor of zoology, West Virginia University, for studies on the endocrines of nutrition; James B. Lackey, professor of biology, Southwestern College, for a study of the effects of variation in environmental factors and in cytological technique upon selected types of cells.

Roland C. Travis, associate professor of psychology, Western Reserve University, for investigation of the speed and characteristics of reflex and voluntary eye movements as indicators of the adequacy of adaptive behavior in children and adults.

SCIENTIFIC NOTES AND NEWS

DR. ROBERT GORDON SPROUL was installed as president of the University of California on October 22, filling the vacancy caused by the retirement of Dr. W. W. Campbell. In connection with the ceremonies the doctorate of laws was conferred on Dr. Thomas Hunt Morgan, director of the Kerckhoff Laboratories of the Biological Sciences of the California Institute of Technology, president of the National Academy of Sciences and of the American Association for the Advancement of Science; on Dr. Arnold Bennett Hall, president of the University of Oregon; on Dr. Albert Russell Mann, dean of the College of Agriculture, Cornell University, and on Charles Derleth, Jr., dean of the College of Civil Engineering of the University of California.

THE John Fritz gold medal, regarded as the highest honor of the engineering profession in America, has been awarded for 1931 to Rear Admiral David Watson Taylor, retired, "for outstanding achievement in marine architecture, for revolutionary results of persistent research in hull design, for improvement in many types of warships and for distinguished service

as chief constructor of the United States Navy during the world war." The award was made unanimously by the John Fritz Medal Board of Award, composed of four representatives each of the four American societies of civil, mining and metallurgical, mechanical and electrical engineers. Recent recipients of the medal include Ralph Modjeski, Herbert Hoover, John J. Carty, Elmer A. Sperry, Edward Dean Adams, John F. Stevens and Ambrose Swasey.

DR. WALTER B. CANNON, George Higginson professor of physiology at the Harvard Medical School, has been elected a foreign honorary fellow of the Royal Society of Edinburgh.

DR. MAX HARTMANN, professor of protozoology at Berlin, and Dr. Eduard Reichenow, professor of protozoology at Hamburg, have been awarded the Fritz Schaudinn Medals.

THE address at the opening session of the School of Pharmacy of the Pharmaceutical Society of Great Britain was delivered on October 1 by Dr. Arthur W. Hill, director of the Royal Botanic Gardens, Kew. The Pereira Medal of the society was presented to him on this occasion.

SIR JOHN RUSSELL, director of Rothamsted Experimental Station, England, has been elected president of the International Congress of Soils. The next congress will meet at Cambridge, England, in 1935, at which time it is proposed to follow the plenary sessions with a soils tour of the Mediterranean countries, including Spain, Algiers, Egypt, Palestine, Greece, Italy and France.

AT the recent meeting of the American Ornithological Union held at Salem, Massachusetts, the following officers were elected: Dr. Joseph Grinnell, University of California, president; A. C. Bebt, Taunton, Massachusetts, and J. H. Fleming, Toronto, vice-presidents; Dr. T. S. Palmer, Washington, D. C., secretary; W. L. McAtee, Washington, D. C., treasurer; James P. Chapin, New York City; Ruthven Deane, Chicago; Harry C. Oberholser, Washington, D. C.; James L. Peters, Cambridge, Massachusetts; Charles W. Richmond, Washington, D. C.; Thomas S. Roberts, Minneapolis, and Percy A. Taverner, Ottawa, members of the council.

AT the annual meeting of the Board of Directors of the Boyce Thompson Institute for Plant Research held at Yonkers, New York, on October 15, Mrs. William Boyce Thompson was unanimously elected chairman of the board to fill the vacancy left by Colonel Thompson's death last July. During his life Colonel Thompson had endowed the institute to the extent of ten million dollars, and had large plans for the further extension of its usefulness, which Mrs. Thompson takes a keen interest in furthering. The other members of the board are: Charles F. Ayer, Raymond F. Bacon, William Crocker, Caleb C. Dula, Frederick H. Ecker, Robert A. Harper, Lewis R. Jones, Thomas Lamont, Fred J. Pope and Margaret Thompson Schulze.

MR. DONALD BISHOP PRENTICE, dean of the department of engineering at Lafayette College, has been elected president of the Rose Polytechnic Institute at Terre Haute, Indiana.

DR. L. R. JONES, of the University of Wisconsin, who has been in charge of plant pathology since the organization of this work, retired in June as chairman of the department, but will continue his other duties on a part-time basis. Dr. G. W. Keitt has been appointed chairman.

DR. F. L. PICKETT, head of the college department of botany of Washington State College, has been appointed dean of the graduate school.

DR. JOSEPH O. CRIDER, dean and professor of physiology and histology at the University of Mississippi School of Medicine, has resigned to become associate professor of physiology and assistant dean in the Jefferson Medical College, Philadelphia. Dr. Crider has been succeeded at the University of Mississippi by Dr. Philip L. Mull, professor of anatomy at the school.

DR. JAMES A. DOULL recently resigned his position as coordinator of the study of common cold which is being conducted at the Johns Hopkins University School of Hygiene and Public Health, to become professor of hygiene and public health at Western Reserve University Medical School. Dr. Doull had been granted a leave of absence as professor of epidemiology at Johns Hopkins to carry on this work.

DR. LEROY C. ABBOTT, chief surgeon at Shriners Hospital for Crippled Children, St. Louis, has become head of the department of orthopedics at Stanford University.

DR. ADDISON GULICK, who has been teaching at the University of Missouri since 1912, since 1921 as professor of physiological chemistry, has been appointed head of the department of biological chemistry.

WE learn from the *Experiment Station Record* that Dr. J. J. Willaman, chief in research in chemistry at the Agricultural Experiment Station at Geneva, New York, has tendered his resignation to enter commercial work. Dr. W. H. Rankin, associate in research (plant pathology) has been granted six months' sabbatic leave to carry on special studies at Cornell University. Dr. P. J. Chapman, entomologist at the Virginia Truck Station, has been appointed chief in

research in entomology. He will direct the new entomological investigations on the apple maggot in the Hudson Valley. Other appointments include George W. Pearce, as assistant in research in entomology, for chemical investigations with insecticides, and H. L. Durham as dairy technologist.

Dr. X. Henry Goodenough, chief engineer of the Division of Sanitary Engineering, Massachusetts, has retired, and Dr. Arthur D. Weston has been appointed his successor.

Dr. S. Herbert Anderson has resigned from the department of physics, University of Washington, to accept the position of physicist in charge of the Signal Corps Laboratories, Fort Monmouth, New Jersey. For the past two years Dr. Anderson has been on leave from the University of Washington at the request of the Daniel Guggenheim Fund for the Promotion of Aeronautics, to investigate the problems of fog flying, at the Wright Field.

Dr. L. I. Shaw has been advanced to the rank of assistant superintendent of manufacturing development in charge of chemical photographic laboratories, cable development application, raw materials and ceramic development of the Western Electric Company, Chicago.

Mr. Neil M. Judd has been put in charge of the new division of archeology of the U. S. National Museum, as curator. It is made up of the former divisions of American archeology and old world archeology.

Dr. Henry Arnstein, who is acting in advisory capacity to the Governments of Argentina, Brazil, Cuba and Colombia, has sailed for South America to deliver a series of lectures on the utilization of natural resources, the elimination of waste and recovery of by-products. Dr. Arnstein expects to return to the United States in January.

Leave of absence has been given by the University of California to Associate Professor R. W. Hodgson to enable him to accept an invitation by the Government of France to visit Tunisia and Morocco and report on the horticultural possibilities of these districts.

Dr. M. L. Nichols, assistant professor of analytical chemistry at Cornell University, has returned to Ithaca after a year's study at the Universities of Leipzig, Graz and Rostock, as a fellow of the Guggenheim Foundation.

Dr. George R. Johnstone is on sabbatical leave for the first semester of the present academic year from the department of botany of the University of Southern California at Los Angeles. Professor A. C. Life, of the same department, will be on sabbatical leave the second half of the year. His work will take him abroad and he will return to the university in the autumn of 1931. Dr. H. de Forest is again chairman of the department, following the custom of a revolving chairmanship.

Dr. H. H. Mann, assistant director of the Woburn sub-station of the Rothamsted Experimental Station, is shortly leaving England for south Russia, to advise as to the possibility of the extension of the tea-growing industry. Before joining the Rothamsted staff, Dr. Mann was engaged in tea research in India.

On October 23 at Boston the Forsythe Lecture was delivered by Dr. Henry C. Sherman, Mitchill professor of chemistry at Columbia University, on "The Significance of the Protective Foods."

The Cutter Lecture on Preventive Medicine of the Harvard Medical School was delivered on October 28 by Professor M. W. Weinburg, of the Pasteur Institute, Paris, on "Anaerobic Infections and their Serotherapy."

Dr. Archibald V. Hill, Foulerton research professor of the Royal Society, lectured on "The State of Water in Tissues" at Northwestern University Medical School on October 20.

At the meeting of German scientific men and physicians held at Königsberg from October 7 to 10 the principal addresses were made by Dr. David Hilbert, professor of mathematics at Göttingen, and Dr. F. Paneth, professor of chemistry at Königsberg. Dr. Hilbert's address was entitled "Naturkenntnis und Logik." Dr. Paneth's address was a memorial to Lothar Meyer.

The International Institute of Agriculture, which owes its existence to the Californian economist, David Lubin, celebrated the twenty-fifth anniversary of its foundation on October 14 in Rome in the presence of the King of Italy, its founder and patron; representatives of the seventy-four states adhering to the institute, and all the highest Italian officials. Premier Mussolini made the principal speech, which was answered by M. Zameta, president of the Council of the League of Nations; M. Vassileff, the Bulgarian Minister of Agriculture; M. Poczinsky, Minister from Poland; Marcel Heraud, under-secretary of the Presidency of France; Sir Daniel Hall, first delegate of Great Britain, and Senator Demuchelis, president of the Institute of Agriculture.

According to an announcement sent by the secretary, Professor Charles P. Berkey, Columbia University, the forty-third annual meeting of the Geological

Society of America will be held Monday, Tuesday and Wednesday, December 29 to 31, 1930, under the auspices of the University of Toronto. The scientific sessions will be held in the Mining and Physics Buildings. The address of the retiring president, Dr. R. A. F. Penrose, Jr., will be delivered Monday evening at the Royal York Hotel, on "Geology as an Agent in Human Welfare," followed by a complimentary smoker. The annual dinner of the society will be held on Tuesday evening. Accommodations are available in the residences of the University of Toronto and meals may be obtained at Hart House. All sessions are open to the general public, but the council requests each fellow to send to the secretary as soon as practicable, and not later than December 15, the names and addresses of advanced students or other persons who are seriously interested in geology and are deserving of recognition as visitors. The council will then invite them to attend the meeting. Visiting ladies should register as arrangements are being made for local entertainment. In conjunction with the society the Paleontological Society will hold its twenty-second annual meeting and the Mineralogical Society of America its eleventh annual meeting. The Society of Economic Geologists will also hold meetings under the same auspices. Section E of the American Association for the Advancement of Science will hold meetings in Cleveland, Ohio, Wednesday, Thursday and Friday, December 31 to January 2. A joint session with the Geological Society of America is being arranged for January 1.

THE second annual Conference of Donors of the Johns Hopkins National Fellowship Plan will be held at the university on November 7. After the speech of welcome by President Joseph S. Ames, the conditions of the annual renewal of fellowships will be discussed under the leadership of Mr. C. G. Campbell, president of the Kewaunee Manufacturing Company, and of Mr. H. A. B. Dunning, president of Hynson, Westcott and Dunning. In the afternoon the selection, education and testing of students who possess creative ability will be considered under the leadership of Mr. Martin Matheson, director, John Wiley and Sons, Incorporated; Professor J. C. W. Frazer, chairman of the Johns Hopkins University department of chemistry; F. O. Clements, director of research, General Motors Corporation, and Dr. A. A. Backhaus, vice-president of the U. S. Industrial Alcohol Company. There will be a luncheon for donors, faculty and fellowship students and a dinner to the donors in the evening. An after-dinner address will be made by Dr. Arthur D. Little, on "Leadership," and a sound picture on "Cosmic Rays," by Dr. Robert A. Millikan, of the California Institute of Technology, will be presented.

UNDER the auspices of the Iowa chapter of Sigma Xi, with Professor G. W. Stewart, national president of the society, presiding, a symposium on the navigation and flood control problems of the Mississippi River was recently presented by A. C. Trowbridge, professor of geology at the University of Iowa; F. A. Nagler, professor of hydraulic engineering, and S. M. Woodward, head of the department of hydraulics.

THE United States Civil Service Commission states that the position of senior toxicologist, Bureau of Chemistry and Soils, Department of Agriculture, is vacant, and that the following method of competition will be used to fill the vacancy. Instead of the usual form of civil-service examination, the qualifications of candidates will be passed upon by a special board of examiners, composed of W. W. Skinner, assistant chief, Chemical and Technological Research, Bureau of Chemistry and Soils; M. X. Sullivan, biochemist, Hygienic Laboratory, and A. S. Ernest, examiner of the United States Civil Service Commission. The entrance salary for this position in Washington is $4,600 a year; if appointment is made to the Field Service the entrance salary may be at any rate within the salary range of $4,600 to $5,400 a year, varying with conditions obtaining at the headquarters where the vacancy exists. For the following-named open competitive examinations applications should be received before November 19: senior technologist (cellulose) with salary range from $4,600 to $5,400 a year; technologist (foods) and technologist (textiles) from $3,800 to $4,600 a year. Applications for geologist for reservoir and dam site investigations must be on file not later than November 26, 1930. The entrance salary is $3,800 a year. This examination is to fill vacancies in the Bureau of Reclamation, Department of the Interior, for duty in Washington, D. C., Denver, Colo., and elsewhere in the field. Competitors will be rated on their education, training and experience, and on writings.

THE Alpha Chi Sigma dinner at the fall meeting of the American Chemical Society was attended by one hundred and twenty members of the fraternity. H. E. Wiedemann, consulting chemist, St. Louis, and a national vice-president of the organization, served as toastmaster. Among the speakers were the national president, Charles A. Mann, head of the department of chemical engineering, University of Minnesota; M. C. Jewett, Procter and Gamble Co., and secretary of the Cincinnati professional chapter; Harry A. Curtis, National Research Council and fraternity historian; Gunnar Carlson, president of Alpha Delta, the local chapter at the University of Cincinnati; E. F. Farnau, professor of chemistry, University of Cincinnati; H. B. Stevenson, Procter and Gamble Co., and associate

editor of *The Hexagon* of Alpha Chi Sigma, and Dr. E. K. Rideal, of Oxford University.

A MEETING of the American Section of the Société de Chimie Industrielle was held at Chandler Lecture Hall, Columbia University, on October 24, 1930. Mr. Arthur H. Sleigh, who as a boy had met Michael Faraday and whose father was intimately acquainted with him, gave his personal recollections—incidentally bringing out the fact that Faraday was greatly interested in botany. Mr. Sleigh exhibited Atkin's book on the flora of Great Britain, published in 1823, which his father and Faraday had jointly used in identifying the plants they found. Dr. René J. Dubos, of the Rockefeller Institute for Medical Research, then addressed the meeting on "Enzymes from Microorganisms and their Application to Industrial and Medical Problems."

A LABORATORY for the study of fresh-water animals of the United States is being installed at the University of Missouri at Columbia under supervision of Dr. Max M. Ellis, director of interior fisheries investigations for the United States Bureau of Fisheries and professor of physiology in the University of Missouri. Its completion within the next few weeks will provide a central point for the observation of chemical and physiological phenomena of fresh-water animals, to which various fresh-water problems of the Bureau of Fisheries will be referred. In order to provide adequate space for carrying on necessary experimental work, the University of Missouri has turned over a section of one of the medical buildings to the work. Funds for the installation of the laboratory were subscribed conjointly by the university and the Bureau of Fisheries.

DISCUSSION

GIBBS'S PHENOMENON

IN May 30, 1930, issue of SCIENCE there appeared a communication from Professor Tomlinson Fort, objecting to the use of the term "Gibbs's phenomenon" for series other than Fourier's series. As the only name which he cites in this connection is my own, readers may possibly infer that I am responsible for this extended use of the term. As this is quite contrary to the fact, I feel that I should make some comment on the point that Professor Fort has raised.

The various developments in orthogonal functions, such as Laplace's functions, Legendre's functions and Bessel's functions, which occur in mathematical physics, present so many analogies to the better-known Fourier's series that it is quite natural and logical to use for the former series an identical terminology in the case of similar properties. So far as Gibbs's phenomenon is concerned this was done as early as 1910 by Weyl[1] in two papers dealing with the behavior of developments in Laplace's functions, Legendre's functions and Sturm-Liouville functions. The extended meaning of the term in the case of Bessel's functions was used by at least one writer[2] prior to my own use of it. The terminology to which Professor Fort objects is therefore not a recent innovation, as his communication may suggest, but a well-established usage on the part of investigators in this field.

Aside from this point, however, I can not agree with several of Professor Fort's contentions. In the first place, the phenomenon in the case of Fourier's series was not first noticed by Gibbs, as he states. It is now well known that it had been pointed out some fifty years earlier by Wilbraham.[3] In the second place, while I entirely agree with Professor Fort as to the fundamental importance of Osgood's classical papers on the general theory of non-uniform convergence, I can not admit that they treat the same point as that involved in Gibbs's phenomenon. In Osgood's discussion the peaks of non-uniform convergence only occur in cases where the limit function is continuous. The examples which he gives of non-uniformly convergent series with discontinuous sum exhibit no peaks. One of the most essential characteristics of Gibbs's phenomenon is the appearance of peaks in the neighborhood of a point of discontinuity of the function developed. I think that it would be quite appropriate to use the term "Osgood's phenomenon" in the case where the limit function is continuous, but not in the situation where the term "Gibbs's phenomenon" has been generally used.

CHARLES N. MOORE
UNIVERSITY OF CINCINNATI

[1] *Rendiconti del Circolo Matematico di Palermo*, 29 (1910): 308; 30 (1910): 377.

[2] *Cf.* R. G. Cooke, *Proc. London Math. Soc.*, 27 (1928): 171.

[3] *Cf.* historical notes by H. S. Carslaw and C. N. Moore, *Bull. Amer. Math. Soc.*, 31 (1925): 420, 417.

THE PRESENT STATUS OF LACTENIN

MENTION was made in an earlier number of this journal of our work on a bacteriostatic substance in milk. To avoid misunderstanding it seems well to summarize the properties and discuss the possible uses in so far as the present status of the problem permits.

It has been known for some time that milk which had not been heated above 60° C. will inhibit the growth of certain bacteria. We have studied the effect of this material on the mastitis streptococcus. It prevents growth for about six hours, after which

growth suddenly begins and continues at a rapid rate. This growth was shown to result from an adaptation of the streptococcus without using up the bacteriostatic substance. We give the name lactenin to this substance. In sufficient concentration it will completely prevent the multiplication of certain bacteria, such as the scarlet fever streptococcus, so that they finally die.

Lactenin preparations contain protein and it may itself be a protein. It is difficult to separate from the other proteins of whey, although the casein can be readily separated from milk leaving whey with the full activity of the original milk. This difficulty is met by digesting the other proteins with trypsin. Mild digestion does not injure the lactenin. The products of digestion can be removed by dialysis, or the lactenin can be precipitated with alcohol.

Owing partly to its combination with calcium phosphate, the lactenin-containing material in concentrated form is quite insoluble and forms at best a poor suspension. It is possible to remove the calcium phosphate, giving a more soluble material, but the conditions must be carefully regulated to prevent inactivation of the lactenin.

Dried lactenin preparations are 200 to 500 times as active as dried skimmed milk. The method used to determine lactenic activity is to measure the size of colonies of scarlet fever streptococcus growing in a thin layer of veal infusion agar jelly to which horse blood is added. The more lactenin present the smaller the colonies will be. One gram of dried material in 100 gallons of this media will produce perceptible inhibition, whereas one gram in 10 gallons will completely prevent the growth of these bacteria.

Either the dried material or neutral suspension of it will keep for months in the refrigerator without loss in activity. It is probably not a pure substance. It contains protein, but no reducing sugar or elements aside from carbon, hydrogen, oxygen and nitrogen. It exists as a salt of whatever cation may be present, particularly calcium, and appears to have a low isoelectric point.

Lactenin, while very active against some micro-organisms, is less active against others.

We make no claims that lactenin is a preservative of the milk or that it could be used for a food preservative. Our investigations have not been concerned with this phase of the question.

It is not known whether lactenin inhibits the growth of mastitis streptococci in the udder, although this appears plausible.

We do not know whether the lactenin in milk has any effect on intestinal infections in animals which drink the milk. It is likely that the stomach acidity would destroy the lactenin.

Since suggestions have been made that lactenin might have a therapeutic value, we would caution against too much hope in this regard until experimental data can be obtained. Satisfactory injections have not been possible up to the present owing to the insolubility of the preparations and the physical properties of the suspensions.

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H. S. Simms
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The Rockefeller Institute,
Princeton, New Jersey

AN ACCESSIBLE TROPICAL VEGETATION

In his description of our collection from Barro Colorado Island Dr. Paul C. Standley[1] states that Mr. Salvoza and I must have visited the island at a particularly favorable time. While that may have been the case still I think the splendid success we had in finding plants new to that region was largely due to the fact that most of our collecting was done along the shore-line with the help of a cayuga (dug-out canoe), which was provided by the laboratory.

The difficulties of collecting in a tropical jungle have long been recognized and with good reason. The very tall trees are much interlaced with vines, and flowers or fruits are almost always inaccessible. When fallen specimens are available it is difficult to know certainly whether they are from one of the tall trees or from a vine which the tree supports.

Barro Colorado Island was cut off from the mainland when the valley surrounding it was flooded to a depth of eighty-five feet to form Gatun Lake and the channel of the Panama Canal.

Since the inundation was of very recent date, no littoral or shore-line vegetation has been formed and the mid-forest types which are almost inaccessible in the interior of the jungle very often overhang the shore with flowers and fruit being borne on the lower branches.

The many long, branched inlets allow a large part of the island to be explored from the shore.

Barro Colorado Island does have on it a most unusual collection of native Central American plants, and without doubt many of them are yet not listed as being present there.

The added feature of the accessibility of the flora makes it unique among tropical floras and speaks well for the foresight of the founders of the Institute of Tropical Research which is situated there.

Walter N. Bangham
Goodyear Plantations Company,
Sumatra

[1] Paul C. Standley, *Jour. Arnold Arboretum*, April, 1930.

THE PRONUNCIATION OF "CENTIMETER"

AT a recent meeting of the American Institute of Electrical Engineers in New York frequent use was made, necessarily, of the word "centimeter." Sometimes it was given a thoroughly Anglicized pronunciation and occasionally an equally good French pronunciation, but several times during the day one would hear a rather unpleasant variation, an unsuccessful attempt being made to pronounce the first syllable as in French while the last was given a distinctly English sound. Since the nasal sound and slight lisp and burr are difficult to the average American, why not adopt the Anglicized pronunciation as the standard for English speech?

EVAN THOMAS

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DISCOVERER OF THE CALCULUS

THE correspondent in your current issue (SCIENCE, August 15, 1930)—Professor G. A. Miller—says on page 168 that English and German writers have long been claiming for their respective countries the honor of having discovered the calculus. Your readers will find in the forthcoming number of *Science Progress* for October a full article by J. M. Child, showing that the calculus was discovered by Newton's teacher, Professor Isaac Barrow, of Cambridge, before 1670. All that Newton added was the algebraic statement of the calculus, while Leibnitz suggested only the algorism now in use. Mr. Child has long been studying the matter and has given it close attention. So far as I can see his contention is perfectly sound, and I think that it was Barrow who invented the calculus. Important works are so apt to be lost sight of in the rush of publications that I think your readers will thank me for calling attention to the matter.

RONALD ROSS
Editor of Science Progress

SPECIAL CORRESPONDENCE

WORK IN PARASITOLOGY AT THE UNIVERSITY OF MICHIGAN BIOLOGICAL STATION

A CENTER for teaching and research in the field of parasitology has been developed in the last few years at the University of Michigan Biological Station on Douglas Lake, Michigan. Researches in this subject at the Douglas Lake station date back to the first collections of parasites made from this region in 1912. During the next five years researches on the life cycles of the digenetic trematodes were carried on by several visiting investigators. Beginning with the session of the summer of 1917, when the directorship of the station was taken over by Dr. George R. LaRue, a regular program of investigations on parasitic worms, chiefly on the trematodes, has been carried out by the director and his students aided from time to time by visiting investigators. In 1927 a regular course was first given at the Michigan Biological Station in the field of parasitology by Dr. W. W. Cort, of the Johns Hopkins University, and Dr. L. J. Thomas, of the University of Illinois. The presence at the station of three men interested in parasitology and representing three different institutions has made it possible each summer to gather together a considerable group of graduate students and visiting investigators in this subject.

The course as at present outlined covers only the field of helminthology. It is limited to graduate students and seniors who have completed sixteen hours of zoology. The lectures are devoted chiefly to the biology of the parasitic worms, but include also reviews of the more important helminths of man and domesticated animals. In the laboratory periods special emphasis is given to the study of living material illustrating all the stages in the life histories of the different groups of parasitic worms. The class makes a number of host examinations and learns the methods of preserving and mounting. In the summer of 1930 each student made for himself a set of about a hundred slides representing all the groups of the parasitic worms, mounted according to a variety of technique methods. In 1929 eleven students were registered in this course and in 1930 the number was nine.

Researches in parasitology at the Biological Station are carried on by the members of the staff, visiting investigators and graduate students. In the summer of 1930 the total group carrying on investigations of some kind or another in this field amounted to sixteen individuals. The subjects that were covered by this group were quite varied. The largest number investigating any one phase of the subject were working on the life cycles of the digenetic trematodes, including studies on the further development of holostome, schistosome and stylet cercariae. Another group was studying the life cycles of tetraphyllidean and proteocephalid cestodes. The other researches on the helminths were concerned with cestode and nematode morphology and with the life cycles of several nematodes in aquatic hosts. The protozoa of the region have been hardly touched. One interesting research on the blood-inhabiting protozoa was carried out during the summer of 1930. Life history studies seem to be best suited to the location and equipment of the Biological Station. The life cycles of a considerable number of parasitic worms have already been worked

out and others are in the process of solution. Facilities are available for the keeping of experimental animals, including an aquarium building and houses for mammals, birds and reptiles. The location of the laboratories in the midst of the lake region of northern Michigan makes available a wealth of problems on the parasites of aquatic animals. A permanent collection of the parasites of the region is being built up which is becoming of increasing value in the researches.

The summer of 1930 saw the moving of the University of Michigan Biological Station into enlarged quarters. Two laboratories are entirely given up to the work in parasitology, and plans are under way to increase considerably the facilities for handling experimental animals for the life history studies and for other types of experimental work. The work is well past the preliminary stages and every indication points to increased development of personnel and facilities. Interest in parasitology has greatly increased in the United States in the last decade, and the development of this center at the Michigan Biological Station will help to meet the demand for summer work in the biological phases of this subject.

W. W. Cort

School of Hygiene and Public Health,
Johns Hopkins University

BOTANICAL LEGACIES OF WALTER DEANE

By bequest of the late Walter Deane, who died at his home in Cambridge, Mass., July 30, 1930, in his eighty-third year, there have been received by the Gray Herbarium of Harvard University: (1) His herbarium, consisting of about 40,000 sheets, selected and mounted with special care, representing chiefly the flowering plants, ferns and fern-allies of the region covered by Gray's Manual; (2) his botanical library, including about 500 volumes; (3) his collection of portraits of botanists.

Mr. Deane, for many years widely known as an enthusiastic amateur botanist with extensive correspondence and wide-reaching exchange relations, was a member of the visiting committee of the Gray Herbarium since 1897, and one of the founders of the New England Botanical Club, being at different times its phanerogamic curator, its vice-president, from 1908 to 1911 its president and for some years its librarian. His botanical specimens were left to the Gray Herbarium with the provision that the New England Botanical Club be allowed to take from them such as might be useful in supplementing its own collections.

Mr. Deane's herbarium has long been noted among American amateur collections of its kind. In it there are many series to illustrate the development of the seedling from earliest germination to normal adult foliage. Particular care was also taken to illustrate the ripe fruit and mature seed, as well as to supply pocket material for dissection. Finally, unusual attention was devoted to the effective exhibition of the roots and other subterranean parts so far as possible.

The collection is historically important since a large part of its specimens have been from time to time studied by specialists and monographers such as Gray, Watson, Bebb, Morong, Davenport and many others, so that the value of the specimens has been greatly increased by critical notes of such authorities recorded during monographic work.

In addition to the valuable botanical collections here described, Mr. Deane bequeathed to the Gray Herbarium the sum of $20,000, the income thereof to be expended in the care of its library, and a further legacy of $25,000 to be paid to Harvard University at the expiration of certain life interests and to be used for the general purposes of the Gray Herbarium. He also left the sum of $1,000 to the New England Botanical Club for the promotion and care of its herbarium.

The passing of Mr. Deane removes from American botany a notable figure. His modesty and enthusiasm as well as his exceptional powers of friendly and helpful interest in the work of others won for him the affectionate regard of all who came into touch with his scientific pursuits.

B. L. Robinson

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN IMPROVED SOIL SAMPLER

Soil samplers of various designs have been employed for many years. The most common tool used in the classification of soil types is the screw type soil auger. A sharp spade and the post-hole digger are likewise frequently employed in securing soil samples. The major disadvantages of these three tools lie in the necessity of handling the sample and in the disturbed condition of the soil. Perhaps the spade and the post-hole digger are not as unsatisfactory as is the screw type auger, but they are awkward to manipulate.

For use on any soil free from gravel or rocks the writer has devised a tool which enables one to obtain a sample in the form of a cylinder of any desired length. This instrument has proved particularly useful in obtaining undisturbed soil samples in nearly natural condition.

The tool is made in one piece. It consists of a heavy galvanized iron pipe 36 inches long and 1¼

inches in diameter, with a one-inch galvanized pipe, 18 inches long, brazed to the top to form a T handle.

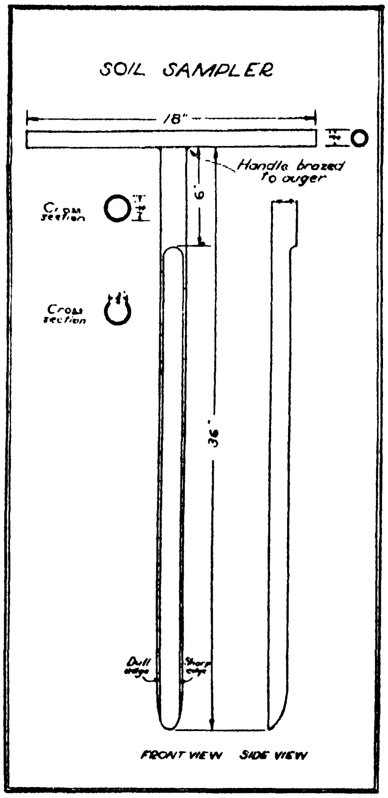

FIG. 1

A ⅜-inch slit is cut in the main pipe, from the bottom to a point six inches below the handle. The right edge of this slit, as viewed from the handle, is dull; the left edge is beveled from within, making a cutting edge 30 inches in length. The lower end of the tool is finished in a rounded point, sharpened at the end.

In operation the tool is simultaneously thrust into the ground and turned gradually to the right in the same manner as an ordinary screw type soil auger. After the tool has entered the soil to the desired depth a slight backward twist releases the core from the main body of the soil. The tool is then slowly pulled out, with particular care to avoid sudden jerks. When the tool is taken from the soil it carries a cylindrical core of slightly compacted soil. A pocket knife is inserted into the soil core at the point where the cylinder begins to taper. This piece of core is pushed out in order to permit the easy removal of the main core from the cylinder. The core can be gradually pushed out in sections, by means of a knife blade or other flat instrument. The emerging core is cylindrical, and it will be found that the interior physical structure has been but slightly affected. The writer has used such a soil sampler at different times and under diverse conditions, always obtaining better results than with the screw-type auger.

L. J. PESSIN
SOUTHERN FOREST EXPERIMENT STATION,
NEW ORLEANS, LOUISIANA

SPECIAL ARTICLES

ADRENAL CORTEX EXTRACT AND CANCER[1]

THE treatment of cancer by glandular extracts has had a moderate study limited by the few glandular extracts existing in pure form. The most recent and highly vaunted treatment has been that of Coffey and Humber,[2] of San Francisco, who used what was said to be an adrenal cortex extract of unstated composition. The curative claims made for their method are so great as to make further study of these extracts of importance in order to establish the place of cortical extracts in the treatment of cancer patients.

A modified adrenal cortex preparation has been described and discussed by Sokoloff.[3] The preparation of Auler and others[4] is unfortunately rather toxic. Kondo[5] was unable to discover any definite evidence that extracts of the suprarenal cortex act as stabilizers of growth in young mammals. The outcome obtained by Joannovics,[6] Pearce and Van Allen,[7] Auler[8] and Floercken[9] is of academic interest only, as removing or destroying the adrenal glands in an effort to elicit a restraining influence on transplanted tumors is an indirect method of approach, after all. Still less direct is the method of Flaks,[10] who mixed the tumor graft with adrenal tissue and found an inhibitory effect when the mixture was tested by injecting into normal animals.

In all these experiments no statement is made as to the efficiency of the adrenal cortex extract in substituting for the glandular hormone itself in adrenalectomized animals. Such an efficient extract has been prepared and described by Swingle and Pfiffner[11] and

[1] From the Cancer Research Laboratories, Graduate School of Medicine, University of Pennsylvania.

[2] W. B. Coffey and J. D. Humber, *J. A. M. A.*, 94: 359, 1930.

[3] B. Sokoloff, *J. A. M. A.*, 94: 652, 1930.

[4] H. Auler, H. Schlottmann, W. Rubenow, P. Meyer and B. Wolff, *Zeits. f. Krebsforsch.*, 32: 195, 1930.

[5] T. Kondo, *Archiv. f. Jap. Chir.*, 6: 62, 1929.

[6] G. Joannovics, *Beitr. z. pathol. Anat.*, etc., 62: 194, 1926.

[7] L. Pearce and C. M. Van Allen, *Trans. Assoc. Amer. Phys.*, 38: 315, 1923.

[8] H. Auler, *Zeits. f. Krebsforsch.*, 22: 210, 1925.

[9] H. Floercken, *Zeits. f. Krebsforsch.*, 24: 465, 1927.

[10] J. Flaks, *Zeits. f. Krebsforsch.*, 30: 145, 1929.

[11] W. W. Swingle and J. J. Pfiffner, SCIENCE, 71: 321 and 489, 1930.

named by them the *cortical hormone*. The method of preparation of this cortical hormone has been fully given, so that there is no secret about it. The extract has been shown to be effective in substituting for the cortical hormone in adrenalectomized cats and is therefore an effective extract. Previously described extracts have not been proved to be effective in preventing symptoms in adrenalectomized animals.

So with an adrenal cortex extract of proved efficiency, experiments were made upon cancer animals. Those chosen were mice with spontaneously developing carcinoma of the breast of a long-established stock. These mice have cancer occurring spontaneously in approximately 20 per cent. of the females. The disease progresses to a fatal result with a known duration and such spontaneous cancers are not subject to the remissions and disappearance of the tumor as are the transplanted, grafted or induced cancers in rats and other animals. In addition, the character of the tumor and its course are more like human breast tumors.

The adrenal cortical extract or cortical hormone was prepared for us by Swingle and Pfiffner[12] and was periodically obtained fresh from their laboratory. There was, therefore, the association of a freshly prepared cortical extract of known and not secret composition and a definite cancer tumor of known character and one which is not subject to remissions.

The subcutaneous dose suggested by Drs. Swingle and Pfiffner was 0.03 cc. This amount, for a mouse weighing 30 gm, would be equivalent to 60 cc in a 60 kgm man. Assuming a life-span for the mouse of 3 years, and for man one of 60 years, 3 months' observation on the mouse would correspond to 5 years on man.

The material was first tested on normal animals, daily injections being given to new-born and premature mice. They did not show any ill effects and developed well, as did their controls, even when the dose was greatly increased. In other words, no stabilization of growth could be demonstrated.

Injections of the same material given to the tumor mice were without any appreciable effect on spontaneous neoplasms of this species; these grew steadily, taking their usual course quite uninfluenced by the treatment. Even when a large dose was given this was also the case. Not a single tumor in two dozen mice was arrested clinically, the results having thus been entirely negative. Death occurred at the customary times in all the animals, and the injections were without effect.

[12] The laboratory wishes to express here sincere thanks to Drs. W. W. Swingle and J. J. Pfiffner, of Princeton University, for their courtesy and their generous gift.

As spontaneous growths of the mouse are analogous with those of man,[13, 14, 15] it is very probable that the treatment here described would be useless in the human patient. The charting of the tumors was done by measurement weekly, and inspection of these shows a continuous and progressive growth in spite of injection of adrenal cortex extract of known efficiency in substitution for the cortical hormone in adrenalectomized animals.[16]

CONCLUSIONS

Spontaneous breast carcinoma in the mouse was treated by the adrenal cortex extract of Swingle and Pfiffner without any curative or restraining effect upon the tumors. No therapeutic value in the treatment of such animal cancers was shown in the cortical hormone, although the efficacy of this preparation in substituting for the adrenal cortex hormone in adrenalectomized animals has been thoroughly proved. The use of such adrenal cortex extract in human patients is not therefore to be recommended as a treatment of cancer but this in no way detracts from the value of this adrenal cortex extract of Swingle and Pfiffner in other conditions than cancer, as it has been proved to be effective as a substitute for the cortical hormone.

SHIGEMITSU ITAMI
ELLICE MCDONALD

THE LIFE CYCLE OF THE PARASITE OF EAST COAST FEVER IN TICKS TRANSMITTING THE DISEASE. (PRELIMINARY NOTE)

EAST COAST fever is a disease of cattle of considerable economic importance which is found on the eastern half of the African continent from the Sudan to the Cape of Good Hope. The causative agent *Theileria parva* is one of a large group of parasites which inhabit red blood cells and are called piroplasms. Perhaps the widest known among the group is *Babesia bigemina*, the organism causing Texas cattle fever, which holds the distinction of being the first parasite definitely proved to be insect (*i.e.*, arachnid) transmitted (Smith and Kilborne, 1893). Despite this early epoch-making discovery the actual life cycle of not a single piroplasm has been completely worked out in the tissues of the transmitting ticks, though many attempts have been made.

The following is a preliminary report of some results secured in an experimental study of the parasite of East Coast fever in ticks (*Rhipicephalus*

[13] F. C. Wood, *J. A. M. A.*, 66: 94, 1916.
[14] W. H. Woglom, *Jour. Cancer Res.*, 7: 379, 1922.
[15] S. Itami, *J. A. M. A.*, 72: 934, 1919.
[16] Illustrations showing the growth will be included in a reprint which will be sent to scientific men who may be interested.

appendiculatus) undertaken at the invitation of the colonial secretary, Lord Passfield, acting for the Government of Kenya, and on the recommendation of Sir Arnold Theiler. The experiments were conducted in the Government Laboratories at Kabete near Nairobi. To both the director of agriculture, the Honorable Alexander Holm, and the chief of the Veterinary Research Laboratory, Mr. James Walker, we wish to express our thanks for many courtesies. We are grateful also to Mr. R. Daubney, who was acting chief of the laboratory during a part of our stay in Kabete; to Dr. E. A. Lewis and to Mr. W. B. C. Danks, both of whom helped us in the actual conduct of our experiments.

The observations were made on six principal series of ticks: (1) Infected as larvae; (2) control, fed on a clean animal as larvae; (3, 4 and 5) infected as nymphae; (6) control, fed on a clean animal as nymphae. They were complicated and difficult for three reasons. First, because in some cases only a relatively small percentage of ticks fed on blood containing parasites retain them throughout their life cycle. Second, the uniform presence of symbionts was a confusing factor in the study of smears soon after engorgement. Lastly, the large majority of the ticks, both infective and clean, contained a protozoan parasite, different from that of East Coast fever, with multiplicative phases in the macrophages in the tick's body and to a lesser extent within the intestinal epithelial cells. All the animals used for the feeding of ticks were carefully reared and free from other tick-borne diseases.

We have found that the life cycle of *Theileria parva* in ticks is divisible into the following stages:

(1) Emigration of parasites from the red blood cells into the gut of the tick begins soon, but parasites may remain in the red blood cells for as long as six days after the ticks drop off engorged.

(2) In the lumen of the gut what appear to be male and female forms are distinguishable, and further examination of the material collected may show that it is here that conjugation takes place.

(3) Many of the free forms in the gut are destroyed *in situ;* others are taken up by the intestinal epithelial cells and digested within them in association with digestive spherules; still others penetrate intestinal epithelial cells, which are not provided with digestive spherules, and grow.

(4) These intra-epithelial parasites make their appearance about the sixth day. From the sixth to the twenty-third day their diameter increases approximately five times. They are recognizable up to the thirty-first day, that is to say over the period of moulting which was accomplished in the several infected series on the twenty-fourth, twenty-fourth, twenty-fourth and eighteenth days after engorgement.

(5) From the day before moulting through the actual moulting and as late as the thirty-first day these intra-epithelial forms change into motile euglena-like forms. These euglenoids penetrate the wall of the intestine and enter the body cavity. They make their way to the salivary glands, where they may be seen in contact with the cells. They were last detected in the four series on the thirty-third, thirty-fourth, thirty-fifth and twenty-ninth days, respectively.

(6) Over a period of several days after their formation the euglenoids enter the salivary gland cells. Their entry was not observed in the larval series, but in the three series of nymphae they were seen as early as the twenty-fifth, twenty-third and twenty-second days.

(7) Once within the salivary gland cells the euglenoids rapidly change into deeply staining spore-like structures, which increase in size to form mulberry-like masses. The peripheral swellings on the mulberries give rise to small forms of the parasite which resemble closely those first observed in sick animals. This is the condition of the parasite usually seen in the salivary glands at the time that the next feeding began on the thirty-third, thirty-sixth, thirty-fifth and twenty-ninth days after engorgement.

(8) During the first four days of feeding the small forms increase greatly in number at the expense of the mulberry-like masses. Many of them are discharged into the lumina of the salivary acini, but some were still seen in ticks as late as the twelfth day after attachment.

The bites of ticks belonging to the series containing these parasites in their salivary glands produced East Coast fever in susceptible animals, whereas those of the control, clean ticks which did not possess parasites failed to do so.

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NATURE AND FATE OF THE METEOR CRATER BOLIDE

By Emeritus Professor HERMAN L. FAIRCHILD

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THE impact origin of Meteor Crater, Arizona, is an accepted fact. The fate or disposition of the colliding body is yet undetermined, and a very interesting problem in cosmic science.

Through many years of exploration, with large expense, the Barringers, father and sons, have collected and published a mass of surprising facts about the crater and its associated meteoric materials. The data, however, have not been marshaled to attack the question of what has become of the greater part of the meteor, except to sustain the theory that the mass lies buried under the south wall of the crater.[1]

The problem of the fate of the meteor involves not only the physical and chemical properties of the discovered meteor fragments but the nature of other meteorites. There are also involved most of the features of the crater and the characters of the rock strata which were disrupted.

CANYON DIABLO SIDEROLITES

The meteoric irons known as Canyon Diablo, from the near-by creek and canyon, have been gathered from the desert plain about the crater to the number of thousands and distributed to institutions all over the world. Because of their number and wide distribution, their inclusion of minute diamonds, their genetic relation to the unique crater and their remarkable chemical and physical characters they are the most interesting and instructive of known meteorites. The facts concerning these irons should give some clue to the character and fate of the giant bolide of which they were a part.

The typical C. D. irons were scattered over the des-

[1] See article by D. M. Barringer, Jr., in the *Scientific American* of July, August and September, 1927. A list of the more important writings is given in SCIENCE, 69: 485–487, 1929.

ert in a radius of four miles and have also been found in the ejecta on the rim of the crater. The largest one weighed about 1,400 pounds. The total weight of all the discovered irons can be only several tons, and they are certainly only a small percentage of the giant bolide. On the supposition that the meteor was wholly nickeliferous iron ballistic calculations have suggested a diameter of about 400 feet and a weight of some ten million tons. The velocity factor, against which the mass must be computed, is unknown. The facts to be described below do not favor a meteor composed wholly of iron.

Exploration—the Rock Strata

The early exploration of the crater assumed that the meteor lay buried under the ninety feet of lacustrine sediment in the floor of the crater and in the subjacent rock débris. After a shaft was found impracticable, because of the copious ground water, drilling was done during the years 1905–1908. Only particles of nickel-iron and some green stain of nickel were found by the drills. But an important discovery was that the deeper rock strata were in continuous and undisturbed position. This ruled out any idea of a volcanic vent or chimney.

The rocks of the region belong in the Grand Canyon Series. They are as follows, in descending order.

(1) On the desert plain, some remnants of the red Triassic sandstone, called Moencopie.

(2) The topmost continuous stratum is the Kaibab, a Permian limestone, 250 feet in thickness.

(3) A white, saccharoidal sandstone, the Coconino; 1,000 feet; also of Permian age. The basal beds of the Coconino carry some yellow and brown color.

(4) Hard, red sandstone, known as the Red Beds, or Supai formation, of undetermined depth in that region.

The central area of the crater was probed by seventeen drill holes, even to the depth of 1,000 feet, or 1,450 feet below the surface of the surrounding plain. This probing passed entirely through the white Coconino sandstone, and penetrated 200 feet into the Red Beds. Seven of the drill holes entered the Red Beds, which were found in place and unchanged. This lowest formation is not represented in the ejected materials composing the crater rim, but samples of the yellow-brown basal rock of the Coconino are found in the ejecta on the southern rim.

During later years, from 1920, exploration has been made on the south border of the crater, on the theory that the bolide fell slantingly from the north and that much of it lies deep under the south wall. This section of the uptilted surrounding rim has been raised about 100 feet higher than elsewhere. The drillers reported meteoric iron from the depth of 1,200 feet down to 1,376 feet, where the drill was stuck and abandoned. Recently a shaft at the locality was a failure because of water and the shattered condition of the rocks. Further exploration is anticipated.

It appears highly improbable, if not impossible, that the mass of the bolide could penetrate to the depth reported for meteoric material. It would have to slantingly traverse some 2,000 feet of rock. And the uplift of the surface should be more than 100 feet. And it is difficult to visualize the mechanics by which detached fragments could reach to the great depth.

Impact Effects on the Rock Strata

The kinetic energy resident in the meteor was instantly expended in several direct effects, as follows:

(1) Crushing of the rocks beneath the locus of impact. The Kaibab limestone which lay immediately beneath the area of impact must have been pulverized to dust and largely swept away in the steam and dust cloud from the violent explosion described below. The underlying Coconino sandrock was shivered to microscopic dust, and much of it was poured out over the crater rim to help form the encircling hills, also described below.

(2) Shattering of the rocks laterally, with expulsion of the rock strata surrounding the impact area. This is attested by the great volume, with huge blocks, of firm limestone which constitutes a large part of the ring of débris.

(3) Vibratory motion which shivered the sand grains of the Coconino sandstone. This is a most interesting feature which has not been sufficiently emphasized. The elevated rim of the crater, averaging 120 feet high above the plain, appearing from a distance and from the Sante Fe Railroad as a range of low hills, consists of the dislodged Kaibab limestone and the crushed Coconino sandstone. This lower formation was affected to its base and largely reduced to dust. Some portion of the kinetic energy in the colliding body was suddenly changed to short-wave vibrations which shattered the individual sand grains. The resulting dust, of angular, crystalline quartz, is of such microscopic fineness that 55 per cent. will pass a 200-mesh sieve. Masses of the rock which to the eye appear as firm sandstone will crush to powder under hand pressure.

(4) If the meteor was largely brittle material, as will be claimed below, it was also shivered. The matter of temperature applies here; also noted later.

(5) Production of intense heat. Theoretically this was inevitable. Clear evidence is found in masses of the Coconino sandstone altered by fusion to "silica glass" or lechatelierite. This required a temperature of 1,400 to 1,800 degrees Centigrade.[2]

[2] See article by A. F. Rogers, *Amer. Jour. Science*, March, 1930.

Further proof is found in rock fragments that carry brown and green stain from vaporized nickel-iron.

REACTION AND EXPLOSIVE EFFECTS

The huge crater was the product of mechanical reaction. The expulsion of rock was partly by the elastic reaction of the compressed strata with its included air, but largely from water expansion.

The sudden compression of the rock strata to a depth of 1,250 feet involved the air which was in the upper strata and the water which saturated the deeper strata.

Standing water deposits, ninety feet thick in the crater floor, consist of marl and peat of organic origin and sand and clay washed in from the basin walls by the "cloud-burst" precipitation of the desert climate. The height of the standing water in the basin shows that the strata were filled with air and water to the depth of 450 feet and below that were entirely saturated with water. As disruption of the rock reached to the base of the Coconino sandstone, 1,250 feet below the land surface, it follows that 800 feet of the porous sandrock, the affected thickness below the later lake level, supplied water for the steam explosion.

In his examination of the crater in 1892 Mr. Gilbert recognized the explosion phenomena, but interpreted them as volcanic. It may be noted that if the explosion had been from subterranean heat this would have involved the porous strata far and wide, and hot-water or fumarolic phenomena would have subsequently occurred for, perhaps, centuries.

The elastic rebound of the compressed rocks and the included air, and the explosive expansion of the suddenly generated steam produced enormous mass movement. This was the expulsion of the meteor itself and of rock material to the depth of 540 feet and over an area three fourths of a mile in diameter.

The size of the crater does not directly indicate the size of the bolide. It is a problem of two indeterminate factors, mass and velocity.

PHYSICAL STATE OF THE METEOR

The temperature of the meteor is a factor of some importance. To the degree that its internal temperature was low the mass was correspondingly brittle, whether iron or mostly stone. If the body had suddenly arrived from extra-solar space, as a casual visitor to our planetary system, it probably had very high velocity, and was intensely cold. And even if it had been aimlessly wandering with some relation to the sun it probably had very low temperature and a velocity not less than that of the observed meteors.

The violent impact which produced so great effect on the earth must have shattered the bolide, whatever its velocity, temperature and substance. If it was largely stony material, as all the facts appear to indicate, the stone was shivered to dust and swept away in a cloud of vapor, in which case only the included, nodular masses of iron-alloy are the existing remnants.

The walls of the crater have receded somewhat under the storm-wash of many centuries, and the débris has produced the talus slopes, giving the concave profile to the basin. The talus and the ninety feet of water deposits have buried any meteor fragments which fell into the basin. But many fragments of the hydrated iron, to be described, have been found in the ring of débris topping the walls. And Brandon Barringer writes that it has been found beneath the talus and against the south wall.

RELATION OF THE IRONS TO THE PARENT BODY

There is no doubt that the thousands of nickeliferous irons found over the desert were associated with the huge bolide. The question is—how did they acquire such dispersion? Were they detached companions of the main body, or are they projected fragments of the disrupted mass?

Dr. O. C. Farrington writes that some specimens of the C. D. irons in the Field Museum have surface features which prove that they fell as individual units. This would indicate that the great bolide did have some free associates, as might be expected. But the fact that the great majority of C. D. irons have irregular forms, with no surficial features produced by atmospheric friction and heat, argues for their inclusion in other material, either as detachments or as an integral part of the great meteor.

If the C. D. irons found over the desert, through a radial distance of four miles, were loose adherents of the central mass, or if they had become detached by the resistance of the earth's atmosphere, then they formed a group some eight miles in diameter. And as distinct units, with original velocity like that of the parent body, the larger ones, with weight of many hundred pounds, should have produced individual craters or pittings in the ground surface. Furthermore, if the typical C. D. irons were only non-oxidizable portions of once larger masses (as some of them certainly are) such larger bodies would have had even greater energy for production of individual craters. If the great bolide buried itself under 1,400 feet of solid rock then the detached units should have behaved in similar manner. But no such pittings of the desert have been noted. Of course, in time the "cloud-burst" storms and high winds of the desert region would obliterate the pittings by filling and such irons as were imbedded would be entirely or partially buried. But all information is to the effect

that all the thousands of collected irons lay exposed on the open surface of the desert.

In this dilemma one suggestion is that the detached units did not imbed themselves but rebounded from their craters.

The iron nodules which were inclusions in the disrupted bolide, and were projected by the explosive reaction, had momentum only sufficient to carry them, like a shot from a mortar, to their positions on the plain. Fragments of the disrupted rocks are reported to lie two miles from the crater. Unfortunately, no facts are available as to the characters of the irons in relation to their distance from the crater.

PHYSICAL AND CHEMICAL CHARACTERS OF THE IRONS

The most interesting and important element in this study is the chemical constitution of the irons. Along with the typical C. D. irons there is at least one other variety. The C. D. type is the unoxidizable and resistant irons which have lain on the desert for a great length of time. They are clearly of nodular character. They generally bear no evidence of frictional passage through the air, but do have the surface features, the irregular shapes and the cavities and perforations of nuclei or enclosed accretions. They are the unoxidized and undecomposed segregations out of larger masses of vanished material. The only doubt is whether the enclosing mineral was decomposable iron or was a stony matrix.

The composition of the permanent, D. C. irons is, by percentage: Iron, 92; nickel, 6; some carbon, with minute diamonds; and small amounts of platinum, iridium, palladium, phosphorus, cobalt and copper.

Associated with the easily recognized meteoric irons was a considerable amount of limonite or hydrated iron. During early exploration this was neglected, under supposition that it was derived from the limestone of the desert surface. Barringer noted that larger fragments had a laminated structure and he called it "iron shale." Later, subspherical masses with concentric lamination were found, especially in excavations in hills of débris, and he called these "shale balls." Then it was observed that some of these masses had a green stain, and chemical examination revealed that they contained the nickel and rare elements of the C. D. irons, and, in addition, chlorine.

A specimen of the meteoric iron, supposed to be the typical C. D., in the Meteor Crater exhibit in the University of Rochester Museum in the course of years disintegrated to powder. If this is another variety of the decomposable iron or if it would have produced the "iron shale" form had it been exposed to open weather is unknown. But it emphasizes the perishable nature of some of the meteorites.

Another important discovery is that nodules of the unchangeable or typical C. D. iron are found in the shale balls. Also, that the decomposable, chlorine-bearing iron is occasionally found in the C. D. irons.

The intimate association of decomposable and of permanent iron clearly explains the cavities, holes and perforations in many specimens of the C. D. meteorites. And a similar cause is suggested for the cavities and perforations in the iron meteorites of other finds, for example, the great Willamette, in the American Museum.

THE ARIZONA BOLIDE A STONY METEOR

The doubt concerning the Meteor Crater visitor is whether it was wholly meteoric iron or was a larger body of stony composition, with iron-alloy inclusions, in other words, was the meteor of iron, with smaller size, of high density and with high velocity, or a larger body of stony substance with iron inclusions, of less density and perhaps with less velocity.

Our ignorance as to the source of meteors and comets does not justify the assumption that great masses of iron alloys, up to 400 feet in dimensions, could not exist, or are not formed in some planetary bodies or in dead suns, or that they may not exist deep within our globe. However, present knowledge of terrestrial and cosmic processes does not suggest the formation of such massive metallic bodies.

The early suggestion that the mass of the bolide might have been mostly stone, instead of metal, has been ignored because no stony material foreign to the local rocks has ever been found, although diligently sought by S. J. Holsinger, who conducted the early studies. But when we recognize the perishable nature of stony meteorites any such material should not have been expected.

The stony meteorites are exceedingly varied and complex in both composition and structure and subject to easy decay by atmospheric agencies. In consequence of this the "finds" of stony meteorites, or their discovery apart from visible "falls," are exceedingly rare. The "finds" are practically all of resistant nickel-iron. In his book on "Meteorites" (1915), Dr. O. C. Farrington states that of 350 falls only ten were of iron. But if the stony meteorites are thirty-five times as numerous as the iron, and yet quite wanting among the finds, it clearly shows their perishable nature. It may also be possible that some of the ten irons included in the 350 falls had quickly lost their brittle and ephemeral matrix before they were located.

The Arizona visitor arrived centuries and perhaps thousands of years ago, and time has been amply sufficient to destroy all the mass except the imperishable iron nodules and some of the chlorine-bearing iron.

It should also be noted that the spasmodic precipitation of the arid region has favored the washing-away of the products of decay, even if this was not all soluble. Doubtless a great quantity of pulverized rock, both limestone and sandstone, was spread widely over the plain. But this has been removed by solution and storm-wash of the torrential rains. The elevated rim of the crater prevented inwash from the surrounding desert.

All the facts concerning the C. D. irons clearly indicate that they were inclusions or nodules of resistant nature, inclosed in some kind of perishable material. And some of that matrix was chlorine-bearing iron.

The rotund or globular form of some of the "shale balls," the decomposable irons, strongly suggests that they also were only concretionary masses in a matrix of other substance. That substance could have been only the stony materials of which most known meteorites are composed. It may not be claimed that because of its greater size the Meteor Crater meteorite was entirely different in source and nature from all other celestial immigrants.

All the facts relating to meteorites in general, and the Meteor Crater bolide in particular, along with the theoretic probabilities, support the view that the Arizona visitor was a very large stony mass with metallic inclusions.

The stony matrix was brittle, even if without very low temperature, and it was shivered by the impact mostly or wholly to dust. And this was thrown high in air, and borne by the steam cloud it was disseminated far and wide, and any large fragments were quickly destroyed by decomposition and hydration.

This conclusion regarding the C. D. irons may imply that many other, if not all, of the known iron meteorites, even the largest, were originally inclusions in perishable matrix. The irregular, angular forms, perforations and characterless surfaces were probably produced by their imbedding as nodules or accretions in other materials. Only the irons which have traversed our atmosphere after losing their protective covering exhibit some frictional and flowage surfaces.

In the above study no estimate has been made as to the kinetic energy resident in the bolide, and the explosive effect has been attributed mainly to the water and air held in the rocks. But if the meteor was large, with high velocity and high density, the impact might have produced sufficient heat to vaporize both the meteor and the crushed rock. And more probably such would have been the case if the bolide was wholly or largely nickel-iron.

In such case the metallic vapor, with terrific expansion in all directions, should have coated all the surviving rocks with a green stain. The absence of such stain is another argument for a stony meteor.

If the meteor was dissipated in vapor then the thousands of C. D. irons found on the desert could not have been part of the main body. With or without enclosing matrix they had become detached from the central mass by atmospheric friction, and so far separated, and perhaps laggard, that they escaped the grand smash-up.

MICROPHONIC ACTION IN TELEPHONE TRANSMITTERS

By Dr. FREDERICK S. GOUCHER
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A MICROPHONE may be defined as a transmitter which makes use of the resistance variation of one of its elements in changing a pressure wave into an electrical one. That element, in the case of our commercial carbon transmitter, is an aggregate of loosely packed carbon granules, which is compressed between the diaphragm and the wall of a cavity in which the granules are held. Other types of transmitters operate in accordance with other principles. Bell's original transmitter, for instance, reversed the action of the present-day receiver and was electromagnetic in its action. The condenser transmitter, now used extensively in the sound picture industry, depends, on the other hand, on changes in capacitance. Neither of these types has the advantage of amplification and high energy output characteristic of the carbon transmitter, and for this reason the latter is used almost exclusively in our present-day telephone system.

Microphonic action as applied to our commercial transmitters has to do then with those physical changes responsible for variations in resistance which take place in the aggregate of granules when this is subjected to variations of stress at audible frequencies. This process is complex, and as yet there has been no experimental demonstration of the precise nature of the changes involved.

HISTORICAL

An attempt at a quantitative theory of microphonic action was made by Professor P. O. Pedersen.[1] He assumed that microphonic action occurs as a conse-

[1] *Electrician*, February 4, 1916.

quence of the elastic deformation of the contact material resulting in a variation of the contact area. Considering the case of two elastic conducting spheres brought into contact, Pedersen assumed that the resistance is made up of two parts: *viz.* (1) the resistance of a conducting film, the specific resistance of which does not change under pressure, and (2) the so-called "spreading resistance" or that which is caused by the concentration of the current flow within the region of the contact area and which would exist independently of any film.

Using well-known principles of elastic and potential theory, he arrived at the equation

$$R=\frac{A}{(F)^{2/3}}+\frac{B}{(F)^{1/3}} \tag{1}$$

where R is the contact resistance, A and B are constants and F is the contact force. The first term on the right is the film resistance which is inversely proportional to the contact area and the second term is the "spreading resistance" which is inversely proportional to the radius of the contact area.

Pedersen tested his theory by experiments on carbon spheres and found reasonable agreement over a wide force range. But there were reasons for doubting the existence of the high resistance film. It appeared reasonable to suppose that contact would not take place over the whole contact area owing to surface roughness (the existence of which could be observed under a microscope especially in the case of carbon) and that this roughness would behave somewhat like a high resistance film. F. Gray, of these laboratories,[2] worked out a theory based on this assumption which was so nearly like Professor Pedersen's that it was difficult to discriminate between them experimentally. He assumed that the microscopic hills in electrical contact not only increase in number as the contact force is increased but that the resistance per hill varies in accordance with the theory of spreading resistance as assumed by Pedersen.

Considering the simple case of two spheres having a surface of ideal roughness consisting of smooth spherically convex hills, the radius of curvature of which is small compared with that of the contacting spheres, he arrived at the relation

$$R=\frac{A}{(F)^{7/9}}+\frac{B}{(F)^{1/3}} \tag{2}$$

The first term on the right shows the effect of the roughness and the second term the effect of the "spreading resistance" which would exist independently of the roughness. This equation differs from Pedersen's only by a factor of $(F)^{-1/9}$ in the first term on the right. Gray also investigated the effect of adding a film to this first order roughness and the effect of adding a second order roughness to the first order roughness and showed that these only serve to modify the equation slightly at small contact forces. A high degree of roughness gives a departure from the inverse 7/9 power law and a transition to the inverse first power law for the case infinite roughness.

Equation (2) was found to fit experimental curves remarkably well at large contact forces and over a very wide range of forces. It thus appeared that surface roughness behaves almost identically with a nonvariable high resistance film. Marked departures from theory were found at very small contact forces, the resistance decreasing too rapidly with an increase in contact force. These departures are no doubt associated with plastic deformation of the contact material, as Gray was able to show.

However, the applicability of the theory to contacts between granules of microphone material was left in doubt, not only because the contact forces in this case are smaller—being of the order of 1 dyne—than those for which the theory had been demonstrated to hold, but also because of several effects which indicated that other factors might be dominant in this region of small contact forces.

For instance, it has been demonstrated[3] that adsorbed films of air are capable of producing a marked increase in the resistance of granular carbon contacts. It is reasonable to assume that these films may play some fundamental part not only in the conduction of current across the contact but in the mechanism of resistance change with variation of contact force. The late Emile Berliner, who was responsible for fundamental developments in carbon transmitters, believed that these air films are all important and even went so far as to claim that an actual gap could be observed—by means of a microscope—between contacts while they were transmitting.

Again there is a marked decrease in the resistance of granular carbon contacts with increase in voltage which has not been satisfactorily explained. This fact suggests among other possibilities that the conduction process may involve the passage of electrons across gaps of molecular dimensions in the manner of a cold point discharge; field gradients of sufficient magnitude to extract electrons from a solid could exist in these gaps with only a fraction of a volt across the contacts. If this were the case microphonic action might well be associated with a variation of the gap dimensions under strain.

Another suggestion has been that the resistance change is a strain phenomenon: that is, owing to cohesion, the contacts may be substantially welded to-

[2] *Phys. Rev.*, 36: 375, 1930.

[3] P. S. Olmstead, *Journal of Phys. Chem.*, 33: 69, 1929.

gether and the resistance is changed in much the same manner as that of a wire under tension or that of a solid under hydrostatic pressure. Bridgman has shown that the pressure coefficient of resistance of carbon is negative, so that we might reasonably expect at least part of the decrease in contact resistance with increase of contact force to be due to this cause. At a very early date Edison advanced the hypothesis that microphonic action is due to a change of specific resistance of the material in the contact junction.

RECENT EXPERIMENTAL WORK[4]

In view of these considerations it appeared very desirable to study the behavior of contacts—particularly those between granules of microphone carbon—under conditions of very small contact force. The work which will here be described has been undertaken with this object in view. A technique has been developed for controlling contact forces of the order of 1 dyne or less, either in the highest vacuum or in any desired gas atmosphere, also for controlling contact temperature over the range of temperatures which, we have reason to believe, covers that which holds for the contacts in a microphone.

The essential features of one of the tubes used in studying these contacts are shown diagrammatically in Fig. 1. The contacts C_1 and C_2 are fastened respectively to a movable base M and to the lower end of a silica helical spring of suitable stiffness. The base M is supported from a fixed frame F by two vertical platinum wires P and two stretched springs as shown. M is moved by heating or cooling the platinum wires, through the passage of current, thereby causing them to expand or contract. In this way the contacts may be made or broken and any desired contact force applied through the compression of the helical spring. Control of the temperature of the contact is obtained by surrounding the contact region with a metal cylinder S which may be heated by means of radiation from a platinum heater H, the temperature within the cylinder being measured by means of a thermocouple placed near the contacts.

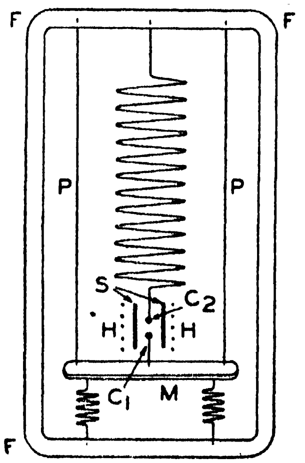

FIG. 1

In practice C_2 consists of a single granule fastened to the end of a platinum wire by means of carbon paste, and C_1 consists of a number of granules attached to a horizontal metal plate by the same means; in this way a variety of contacts can be studied with the same tube. A small hole in the metal cylinder surrounding the contacts permits of direct observation of the contacts during measurement.

When set up for measurement the tube is suspended by rubber bands within a massive metal container which serves to protect the system from acoustic shock. This container is mounted on a suspension to minimize the effect of vibrations. Two reading telescopes are mounted in the side of the container for the purpose of measuring the spring compression, the lower one being focused directly on the contact.

Measurements made with this device have enabled us to draw a number of conclusions in regard to the nature of these contacts and their behavior when the contact force is varied.

In the first place, we have identified the conducting portions of the contacts as of the nature of carbon by means of measurements on the temperature coefficients of resistance of contacts. It is well known that the temperature coefficient for carbon is negative—as opposed to a positive value for most conductors—and the magnitude of this coefficient for the contacts was found to be of the right order and sign for solid carbon, prepared by special heat treatment. The value of the contact temperature coefficient may be modified by heat treatment of the carbon which probably does not affect its interior so that we have reason for believing that the surface material is a somewhat different carbon from that inside.

The magnitude of the temperature coefficient of resistance was found to be independent of gas pressure even though the presence of gas increased the contact resistance. The gas therefore must act as a non-conducting film limiting the areas of the conducting portions of the contact and not affecting their nature.

A reversible change of contact resistance with applied contact voltage—the resistance decreasing with an increase of voltage—was found to be due entirely to the heating of the contacts arising from the passage of current. This was shown by comparing contact behavior at known temperatures with that at known voltages and checking the theory of contact temperature arising from the heating effect of current. This theory based on earlier work of Kohlrausch had been

[4] F. S. Goucher, *Phys. Rev.*, 35: 1429, 1930; 36: 375, 1930.

worked out previously in these laboratories by F. Gray[5] and independently by R. Holm.[6] The theory gives as an approximate formula

$$T = \text{const.} \frac{V^2}{K_0/\sigma_0} \qquad (3)$$

where T is the increase of temperature above room temperature, V the contact voltage and (K_0/σ_0) the ratio of the thermal to electrical conductivity of the contact material. A reasonable value of (K_0/σ_0) for carbon is obtained from these experiments. The conduction process is thus shown to be that which occurs in solid carbon, and no other effect, such as electronic discharge across small gaps, can be an important factor. This result is therefore in line with recent experiments of Holm[7] which have demonstrated the metallic nature of contacts between metals, and of carbon for relatively large contact forces.

The following experimental results have a direct bearing on the mechanism of change of resistance with change of contact force. Reversible resistance changes accompanying changes of contact force between fixed limits are obtained with these contacts, the resistance decreasing with increase of force. Also, the temperature coefficient of resistance is found to be substantially constant as the resistance is varied over a wide range in such a reversible cycle. Both these facts point to area change as the cause of the change of resistance with force, since we know that the elastic deformation of a contact would produce a change in contact area of the required type, and also since we might expect a measurable change in the temperature coefficient of resistance if the state of strain within the contact region were markedly altered. Although the mean stress within the contact area alters somewhat with the contact force, even when the area changes in accordance with elastic theory, this effect is relatively small.

These conclusions concerning the nature of the contacts and the mechanism of resistance change with contact force are in line with the assumptions underlying Gray's equation. Accordingly a study was made of the slopes of the reversible resistance force cycles for both single contacts and aggregates.

The technique used for the study of aggregates was similar to that employed for the single contacts with the exception that the lower contact C_1 consisted of a shallow cup with a conducting bottom and containing a large number of loosely packed granules several layers deep. The upper contact was made by cementing a large number of granules to the bottom of a conducting plate, the cement being such as to give a low resistance contact.

The experiments showed that for any reversible cycle the relation between the resistance and force was of the form

$$R = K\,(F)^{-n} \qquad (4)$$

in the case of both single contacts and aggregates. The exponent n varies somewhat from cycle to cycle when the force limits are the same and its average value depends on the force limits.

The largest values of n were obtained with the aggregates under such conditions of force limits as to indicate that the elastic straining of the aggregate during the cycle was relatively large. A maximum mean value substantially independent of the force limits over a wide range closely approaches 7/9, which is the maximum value consistent with equation (2). This indicates that with sufficiently large strains the aggregate may be made to act as though it were a single contact between spheres having rough surfaces obeying the laws assumed in the derivation of equation (2). On the other hand, for relatively small strains the value of n diminishes to values smaller than the theoretical minimum 1/3 consistent with equation (2). The measured values of n for single contacts are in general less than 1/3 and may become very small if the contact forces are large. These departures from theory appear to be associated with internal contact forces or cohesion which render the contacts relatively insensitive to changes in the applied forces. The existence of cohesion was readily demonstrated by the fact that the contacts always required a finite force to break them even when no current had passed through the contact.

All the experimental results are therefore consistent with the theory of area change due to the elastic deformation of the contact material. Furthermore, the realization of the theoretical maximum value of n in the case of the highly strained aggregates indicates that in a granular mass deformed elastically not only do the contact areas change in the case of those contacts already established, but that new contacts possibly between other granules may be made and broken in a reversible cycle.

OBITUARY

MEMORIAL TO JAMES MELVILLE GILLISS

THE Secretary of the Navy has forwarded to the Ambassador at Santiago, Chile, a bronze bust of the late Lieutenant James Melville Gilliss, U. S. Navy. Mrs. Louise Kidder Sparrow, of Hyannis, Massachusetts, was the sculptress. Congress on June 9, 1930, passed an act providing an appropriation to procure for presentation to the Chilean National Observatory,

[5] Unpublished.
[6] *Z. tch. Phys.*, 3: 290–294, 320–326, 349–357, 1922.
[7] *Wiss. Ver. a. d. Sieman's-Konzern*, 7: 217–271, 1929.

through the Secretary of the Navy, in the name of the United States Naval Observatory, a bronze bust of the late Lieutenant Gilliss, whose memory is honored by officials of Chile.

According to information sent from the Navy Department, Lieutenant Gilliss was the first to conduct a working observatory in the United States and to give his whole time to practical astronomical work. He published the first volume of observations and prepared the first catalogue of stars and planets compiled in the United States.

Lieutenant Gilliss was born in Georgetown, District of Columbia, September 6, 1811. He entered the United States Navy as a midshipman at the age of fifteen and served on the U. S. S. *Delaware*, ship-of-the-line, the *Concord* and the *Java* until 1831, when he was promoted to the rank of passed midshipman. He spent a year at the University of Virginia and later studied in Paris. In 1837, he succeeded Lieutenant Charles Wilkes, who was organizing his expedition to the Antarctic, in charge of the Depot of Charts and Instruments then located in Washington, D. C., on a site about 1,000 feet north of the Capitol.

In 1842, a bill was passed by Congress authorizing the establishment of an astronomical observatory and Gilliss prepared the plans for the building and arranged for the instruments. The site of the new building, the Naval Observatory, was on Braddock Hill, where the Washington, D. C., Naval Hospital is now located, 23d and 25th Streets between E Street and Potomac Park, N. W.

Gilliss's connection with astronomical observations, covering the period from 1838 to 1842, brought him in contact with Dr. Gerling, of Marburg University. Dr. Gerling proposed a new method of deducting the solar parallax from observations of Venus taken from points as far apart as possible in opposite hemispheres, but nearly on the same meridian.

These requisite physical conditions suggested to Gilliss that the obvious place for the other observatory was in Chile. His efforts finally brought authorization for funds from Congress, the project awakening world-wide interest, and he was assisted in his plans and assembling of equipment by some of the most prominent scientists of the day.

Upon the completion of the new observatory in Washington, Gilliss was assigned to duty on the Coast Survey in reducing for its use the entire series of moon-culminations previously observed and published by him. From November, 1848, to 1852, he was engaged in making observations for the determination of the solar parallax.

In August of 1849 he sailed for Valparaiso at the head of a scientific expedition. He located at Santiago, Chile, where he found atmospheric conditions, the necessary physical comforts and availability of repair facilities ideal. The Chilean Government rendered every assistance to Lieutenant Gilliss. There he completed a series of observations of great value. He likewise accumulated a vast amount of information concerning earthquakes and other subjects.

When Gillliss's work was finished, the interest he had awakened in astronomy did not flag. Chileans desired to found a National Observatory. The observatory which Gilliss had established was turned over to Chile as the Chilean National, hence the Chileans' affectionate reference to Gilliss as "the father of astronomy in Chile."

He visited Peru in 1858 to observe the total eclipse of the sun and in 1860 observed a total eclipse of the sun in the Washington Territory. In 1861, he was assigned to take charge of the Washington Naval Observatory. He died in Washington, D. C., in February, 1865.

RECENT DEATHS

DR. ELLWOOD HENDRICK, curator of the Chandler Chemical Museum of Columbia University and author of many books popularizing chemistry, died on October 30, at the age of sixty-eight years.

DR. HORACE E. STOCKBRIDGE, formerly director of the Indiana Experiment Station and from 1890 to 1894 president of the North Dakota Agricultural College, died on October 30, aged seventy-three years.

DR. PRESTON M. HICKEY, head of the department of roentgenology of the University of Michigan, died on October 30. He was sixty-four years old.

THE death at the age of eighty years is announced of George McLane Wood, for twenty-five years editor of the United States Geological Survey in Washington. He had served with the survey from 1886 to 1925.

ACCORDING to a press dispatch Max von Pidoll and his wife committed suicide simultaneously, but in different localities, on October 29. Dr. von Pidoll, who had recently been appointed professor of mathematics in the University of Innsbruck, had suffered from a chronic illness. He was forty-three years old.

Nature reports the death of Dr. D. Adamson, past president of the Institution of Mechanical Engineers, on October 11, aged sixty-one years; of Dr. H. R. H. Hall, keeper of the Egyptian and Assyrian Antiquities, British Museum, on October 13, aged fifty-seven years; of Professor Paul Wagner, director of the Agricultural Research Station at Darmstadt from

1872 until 1923, on August 26, aged eighty-seven years, and of Dr. C. Powell White, for some years director of the Helen Swindells Cancer Research Laboratory at the University of Manchester, pathologist at the Christie Hospital, Manchester, and a member of the executive committee of the British Empire Cancer Campaign, on September 26, aged sixty-three years.

SCIENTIFIC EVENTS

THE AMERICAN ASSOCIATION'S GRANTS FOR RESEARCH

THE American Association for the Advancement of Science grants each year a number of awards to aid in research. The next allotment of these grants will occur during December, 1930. Applications should be addressed to Burton E. Livingston, permanent secretary, Smithsonian Institution Building, Washington, D. C., and should be in his hands not later than December 1.

There will be available for the next year a total of about $3,000. The amount of the individual grants is usually for sums of from $50 to $500. The grants are designed to assist research projects in which some financial assistance will make possible the carrying on of investigations that would otherwise be handicapped. They may be used, for example, for purchasing special apparatus or special facilities that are otherwise unavailable. Application blanks for these grants may be secured from the office of the permanent secretary, although it is not necessary that such special application blanks be used. It is, however, important that any application be supported by letters from qualified scientific men who are acquainted with the proposed research.

These applications are considered by a committee on grants for research, which consists of the following members:

Walter S. Adams, astronomy.
Charles P. Berkey, geology.
Arthur H. Compton, physics.
Karl F. Kellerman, botany.
W. Lash Miller, chemistry.
George H. Parker, zoology.
Oswald Veblen, mathematics.
William C. White, medicine.

Announcement regarding the awards of the grants will be made in January, and the funds can then be secured on demand. When a grant is awarded, it is expected that its recipient make a report within a year as to the progress of the research for which the grant is intended. A report of some kind should be submitted also when the studies are brought to a conclusion. Such a report should give detailed references to any publication that has been made on the grant project, and if reprints or copies of these publications are available they should be included. It is expected, also, that suitable acknowledgment be made for the financial aid given from such a grant when the results of the studies are published. This acknowledgment might take such a form as "Financial aid for the work here reproduced was received from the American Association for the Advancement of Science in the form of a grant for the year 1931."

ARTHUR H. COMPTON, *Chairman,*
Committee on Grants for Research

HEALTH SURVEYS BY THE YALE SCHOOL OF MEDICINE

CONSTANTLY increasing interest in public health is being evidenced by Connecticut communities, according to a statement made by Dr. Ira V. Hiscock, professor of public health in the Yale School of Medicine. At the present time the department is conducting surveys in four cities and towns, Winsted, Stratford, West Hartford and Haddam. In each instance the study is being made at the request of the community and with the approval of the local health officer and of the state department of health.

Similar surveys, or "public health inventories" have already been made in Greenwich, North Haven, Westport, Middletown, Hartford, Ansonia, New Haven, Hamden, Manchester and Danbury. The printed report of the Danbury survey has just come off the press.

By the terms of the endowment the department of public health at the Yale School of Medicine is charged with the obligation to promote the general cause of public health in the state of Connecticut. Its expert services are therefore placed at the disposal of any community desiring to take stock of conditions pertaining to the health of its members and to inaugurate such measures as may be needed to improve them. Although these services are given without charge, the department makes certain requirements in order to be sure that its efforts will bear fruit. The community must guarantee the full cooperation of all its agencies; a permanent committee must be formed to assist in an advisory capacity in making the survey and to see that the recommendations resulting from the study are carried into effect in so far as possible. The community must also pay the

traveling expenses of the staff and the cost of printing the report.

This work was commenced in 1917, and during the past four years has become so extensive that the staff of the department of public health devotes a considerable amount of its time to it. Selected graduate students also assist in the field work. In general, the department feels a responsibility toward the health programs of the state similar to that which the clinical departments of the School of Medicine bear toward the wards and dispensary of the New Haven Hospital. Full cooperation of state health agencies, including the department of health, dairy and food commissioner, commissioner of domestic animals, water commissioner and department of education is always obtained.

In addition to these health survey activities in Connecticut, Dr. C.-E. A. Winslow, head of the department, and Professor Hiscock have been called upon individually to conduct or assist in conducting health surveys in many communities outside the state, among them Boston, Worcester, New Bedford, Minneapolis; Cattaraugus County, New York, Los Angeles County, Santa Barbara County, California, San Francisco, Honolulu and Kansas City. The department has been called upon to make so many surveys in Connecticut that appointments are now made a year in advance.

ENLARGEMENT OF THE HARVARD PHYSICAL LABORATORIES

Harvard's new research laboratory of physics, now under construction, which is to connect the present Jefferson and Cruft physical laboratories, should be completed by the middle of February, according to Dr. F. H. Crawford, instructor and tutor in the division of physical sciences, in a statement for the Boston *Transcript*.

The research laboratory will be approximately two-thirds the size of the Jefferson laboratory and will be devoted entirely to research. In conjunction with its erection, the interior of Jefferson laboratory will be completely remodeled affording much greater laboratory space for students than is now available. The new building has been made possible by an endowment fund raised during the last two years by alumni and many others interested in the physical sciences.

In the basement of the new laboratory will be rooms for high-pressure experimentation, for x-ray apparatus, and for research in high frequency and vacuum tubes. Beneath this will be a sub-basement where there will be a special x-ray work-room sheathed in lead to prevent the filtration of the rays into photographic appliances or other apparatus that they would harmfully affect. The basement is to be equipped with double walls which will prevent outside disturbances from affecting the extremely delicate measurements essential to research. Rooms will be sound-proof and of constant temperature. A huge one hundred thousand volt storage battery, one of the largest of its kind in the world, will also be situated underground.

The second floor will be devoted to offices, conference rooms and a section for high frequency and radio research work. The latter is placed near the Cruft laboratory end. According to the contractor's specifications, the new building will have a volume of about five hundred thousand cubic feet and the walls of the library, lecture room and corridors will be coated with a special sound-absorbing plaster.

All motors will be mounted so as to counteract vibration. Another precaution against unnecessary noise is that special blocks of wood will be set in the wall to facilitate the attachment of machines at any time. There will be special electrical connections between all the rooms so that any voltage may be obtained throughout the building. All machines in the laboratory will have their own motors obviating the necessity of setting in motion a large system of generators and pulleys.

The third floor will house a physics library done in oak panelling which will be adjacent to a large conference room. The top floor will be given over to offices, small research rooms and a department devoted to computing equipment.

THE SEMI-CENTENNIAL OF THE NEW JERSEY STATE EXPERIMENT STATION

The completion of fifty years of service to agriculture by the New Jersey State Agricultural Experiment Station was celebrated at New Brunswick on October 8 and 9. The exercises included a large outdoor meeting under the auspices of the station, at which the principal speaker was Dr. A. F. Woods, director of scientific work of the U. S. Department of Agriculture, and a convocation by Rutgers University addressed by Sir John Russell, director of the Rothamsted Experimental Station, and followed by the conferring of the honorary degree of doctor of science upon six scientific men of international reputation.

These were Dr. L. O. Howard, long chief of the Bureau of Entomology; Dr. C. F. Marbut, chief of the Soil Survey Division; Dr. Theobald Smith, director of the department of animal pathology of the Rockefeller Institute for Medical Research; Sir John Russell, Dr. S. Orla-Jensen, of Denmark, an authority in dairy bacteriology, and Dr. L. B. Mendel, of Yale University, known for his studies in food and nutrition.

H. L. Knight, editor of the *Experiment Station Record*, states that the New Jersey station is one of

the pioneer experiment stations in this country. It was organized by act of the state legislature in 1880, thus antedating the Hatch Act by 7 years, and is still maintained without direct federal aid, though associated closely with the New Jersey College Experiment Station under a common directorship since 1895. Its establishment and early development were due largely to the efforts of Dr. George H. Cook, professor of chemistry and natural science in Rutgers, who was its director until his death in 1889. Its subsequent growth and progress have been profoundly influenced by Dr. E. B. Voorhees, its director from 1893 to 1911, and Dr. J. G. Lipman, director since 1911. A feature of the celebration was the unveiling of a memorial tablet commemorating the services of Dr. Cook and Dr. Voorhees.

SCIENTIFIC NOTES AND NEWS

ACCORDING to an Associated Press dispatch from Stockholm the Nobel Prize in medicine has been awarded to Dr. Karl Landsteiner, formerly of the University of Vienna and since 1922 a member of the Rockefeller Institute for Medical Research in pathology and bacteriology.

DR. OTTO FOLIN, professor of biochemistry at Harvard University, has been named as the first recipient of the Scheele Medal, awarded him by the Chemical Society of Stockholm. Award of the medal was announced in connection with the dedication of the Institute for Biochemistry building in Stockholm.

THE Perkin Medal for 1931 has been awarded to Arthur D. Little. This medal is awarded on a basis of a lifetime of achievement by a committee composed of representatives of five leading chemical societies. The presentation will be made at a joint meeting of the societies to be held on January 9, probably at the Chemists' Club, New York.

DR. HUGH S. CUMMING, surgeon-general of the United States Public Health Service, was installed on October 31 as president of the American Public Health Association, succeeding Dr. A. J. Chesley, of St. Paul, Minnesota. Dr. William C. Hassler, health officer of San Francisco, was named president-elect to take office when Dr. Cumming has completed his term in 1931. Other officers named who will assume office next year are Dr. Rafel Silva, of Mexico, first vice-president; Dr. J. W. S. McCullough, of Toronto, second vice-president; Dr. A. H. Flickwir, of Fort Worth, third vice-president; Dr. Louis I. Dublin, of New York, treasurer, and Dr. W. S. Rankin, of Charlotte, North Carolina, chairman of the executive board. Mr. Homer N. Calver, of New York, was reappointed executive secretary.

AT the forty-first annual meeting in Denver, October 14–16, of the Association of American Medical Colleges, the following officers were elected: *President,* Dr. Maurice H. Rees, Denver; *Vice-president,* Dr. Charles C. Bass, New Orleans, and *Secretary-treasurer,* Dr. Fred C. Zapffe, 25 East Washington Street, Chicago (reelected). The next annual meeting will be held in New Orleans in 1931.

DR. CARLETON R. BALL, formerly principal agronomist in charge, Office of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and now engaged in agricultural writing, was elected president of Gamma Sigma Delta, Honorary Society of Agriculture, at its annual meeting on October 14.

CARLOS E. CHARDON, commissioner of agriculture of Porto Rico, has been elected chancellor of the University of Porto Rico, succeeding Dr. Thomas E. Benner, who is now at Teachers College, Columbia University. Commissioner Chardon, who is thirty-three years old, is a graduate of Cornell University and is the first Porto Rican chosen to head the university.

DR. A. L. STRAND, of the University of Minnesota, has accepted the appointment as head of the department of entomology at the Montana State College, Bozeman, succeeding Professor R. A. Cooley, who will devote himself to research work. The appointment carries with it the positions of entomologist of the experiment station, state entomologist and secretary of the State Board of Entomology.

DR. RALPH W. CHANEY, of the Carnegie Institution of Washington, who has been carrying on teaching in the department of paleontology at the University of California during the past semester in conjunction with his work for the institution, has been appointed lecturer at the university. He is instructing some of the classes which were given by Professor W. D. Matthew, chairman of the department, whose death occurred on September 24.

RAYMOND H. ROGERS, class of 1925, New York State College of Forestry, in charge of the Iroquois Forest of F. Ambrose Clarke, Cooperstown, New York, has been awarded a forestry fellowship by the Charles Lathrop Pack Forest Education Board.

DR. H. T. HILLSTROM, of the University of Minnesota, has been appointed head of the department of roentgenology and radio-therapy at Vanderbilt University.

Nature reports that the council of the University of Manchester has accepted with regret the resignation of Professor O. T. Jones, who has held the chair of geology and the directorship of the Geological Laboratories since 1919. Professor Jones has been elected to the Woodwardian chair of geology in the University of Cambridge, and will vacate his Manchester appointment in December. The council has also accepted the resignations of Dr. John Walton, senior lecturer in botany, who has been elected to the Regius chair of botany in the University of Glasgow, and of Mr. L. J. F. Brimble, lecturer in botany.

DR. J. E. ACKERT, professor of zoology, experiment station parasitologist and chairman of the graduate council in the Kansas State Agricultural College, is spending the year 1930–31 abroad. He participated in the fourth World's Poultry Congress in London in July, and the eleventh International Zoological Congress in Padua in September. Dr. Ackert will be at the Molteno Institute of Parasitology, University of Cambridge, England, during the rest of the year.

PROFESSOR A. ELIZABETH ADAMS, of the department of zoology at Mount Holyoke College, is carrying on investigations in the department of animal genetics at the University of Edinburgh, Scotland.

J. E. CHAPMAN, assistant professor of agronomy of the North Dakota Agricultural College, has returned from Cornell University where he spent his sabbatical leave in study for an advanced degree.

DR. A. H. GEE, assistant professor of bacteriology at the Scripps Institution of Oceanography, the University of California, has returned from a summer spent at the Laboratory of the Carnegie Institution at Tortugas, where he made a collection of representative corals which has been added to the series of collections of the Scripps Institution.

DR. AND MRS. WILLIAM M. MANN left Washington on October 24 for New York City where they embarked for points in Panama and Honduras. The trip is primarily a vacation, but it is anticipated that Dr. Mann will obtain both plants and animals that will be needed for stocking the Reptile House of the National Zoological Park, which should be in condition to receive them upon his return early in December.

DR. ANSON HAYES, director of metallurgical research with the American Rolling Mills Company, was the guest of honor and speaker at a dinner of Sigma Xi at Iowa State College on October 23. He addressed the society on "Industrial Research and Some of the Tools it Uses."

DR. WILLIAM MCPHERSON, president of the American Chemical Society, is making a lecture tour of twenty-two local sections of the society. He is addressing sections in Kentucky, Indiana, Illinois, Missouri, Kansas, Oklahoma, Texas, Louisiana, Alabama, Florida, Georgia, Tennessee, North Carolina, Virginia and West Virginia. The titles of his lectures are (1) "Methods of Nature"; (2) "Reminiscences of Great Teachers of Chemistry," and (3) "Chemistry of Organic Compounds of Titanium." His tour began on October 27 and ends on December 5. These lectures were arranged by the local section officers committee, of which Dr. Ellice McDonald is secretary.

THE second Henry Herbert Wills Memorial Lecture in physics, founded to commemorate the gift of the laboratory to the University of Bristol, was given by Professor J. Franck, of the University of Göttingen, on October 25, in the Henry Herbert Wills Physical Laboratory. The title of the lecture was "Relations between Spectroscopy and Chemistry."

CLARENCE H. MACKAY, president of the Postal Telegraph Cable Company, dedicated and laid the cornerstone of the new Mackay Science School building at the University of Nevada on October 24 for which Mr. Mackay gave the university $415,000, bringing the total gifts to the university of the Mackay family to more than one and a half million dollars. Judge George S. Brown, president of the Board of Regents, accepted the gift.

IN accordance with an agreement made by the Boards of Trustees of Ohio Wesleyan University and Ohio State University, students registered in the latter institution may carry on research work in astronomy and astrophysics at the Perkins Observatory of Ohio Wesleyan University under the supervision of its director. Graduate work may be arranged on the terms of the agreement which will lead to the degree of doctor of philosophy in astronomy and astrophysics, the degree to be granted by the Ohio State University, and the work to be published in the *Contributions* of the Perkins Observatory.

DR. RICHARD T. FISHER, director of the Harvard Forest, announces that an endowment fund of $200,000 has been created for research work in the forest. The endowment will be known as the Charles Lathrop Pack Forestry Fund. Mr. Pack gave $100,000 on condition that the same amount should be raised from other sources; that provision has now been fulfilled. The Harvard Forest is at Petersham, Massachusetts, where about 2,000 acres of valuable timberland were acquired in 1907 through the generosity of John S. Ames, '01. Several neighboring tracts have since been added.

THE *American Journal of Cancer,* the first number of which will appear on January 1, is a direct continuation of *The Journal of Cancer Research* which originated with the American Association for Cancer Research. The publication of the new journal has been rendered possible by the generosity of Mr. Garvan and Mr. Buffum, of the Chemical Foundation. The next number will be Volume xv, thus directly continuing *The Journal of Cancer Research.* With the ample funds which have been provided, it will be possible not only to print the research articles which have been appearing in *The Journal of Cancer Research,* but also to include clinical, statistical and educational aspects of cancer, together with abstracts of the most important articles on cancer. Dr. Francis Carter Wood will be the editor, and the journal will be published at Crocker Institute of Cancer Research, 1145 Amsterdam Avenue, New York.

BEGINNING January, 1931, the American Society of Clinical Pathologists will publish a bi-monthly journal known as the *American Journal of Clinical Pathology.* This journal will publish original papers dealing with all phases of clinical pathology and closely related subjects. The editors will also make an effort to publish articles dealing with new methods and comparisons of old methods in the application of clinical pathology to medicine and surgery. Manuscripts should be sent to Dr. T. B. Magath, editor, Mayo Clinic, Rochester, Minnesota. The advisory editorial board consists of Drs. J. A. Kolmer, A. H. Sanford, B. C. Crowell, R. A. Keilty, F. W. Hartman, Herbert Fox, K. M. Lynch, S. P. Reimann, W. S. Thomas, C. S. Butler, R. A. Kilduffe and H. J. Corper.

THE appointment of Dr. W. B. White, chief of the food control laboratory, Food and Drug Administration, U. S. Department of Agriculture, as a member of the Food Standards Committee, was approved on October 14 by Secretary of Agriculture Arthur M. Hyde. This appointment fills the vacancy created by the death of Dr. R. W. Balcom, former chief of the food control laboratory. The Food Standards Committee consists of nine members, three representing the U. S. Department of Agriculture, three the Association of Dairy, Food and Drug Officials of the United States and three the Association of Official Agricultural Chemists. The committee acts in an advisory capacity to the Secretary of Agriculture and to the Food and Drug Administration. Its personnel, in addition to Dr. White, is as follows: W. C. Geagley, state analyst, Department of Agriculture, Lansing, Michigan; E. L. Redfern, chief chemist, Department of Agriculture, Des Moines, Iowa; Guy Frary, state chemist, Vermilion, South Dakota; I. L. Miller, state food and drug commissioner, Indianapolis, Indiana; Dr. E. M. Bailey, chemist, Agricultural Experiment Station, New Haven, Connecticut; Charles D. Howard, chief, Division of Inspection, State Board of Health, Concord, New Hampshire; W. S. Frisbie, Food and Drug Administration, U. S. Department of Agriculture, chairman, and A. S. Mitchell, Food and Drug Administration, secretary.

A PLAN for the formation of a research foundation was under consideration by the American Congress of Physical Therapy, recently in session in St. Louis. The proposal for the foundation was offered by Dr. John S. Hibben, of Pasadena, California. The plan suggests the organization of a research council on physical therapy under the direction of the congress. Several St. Louis philanthropists have expressed a willingness to finance a research program over a five-year period. Approximately 1,000 physicians and surgeons attended the congress.

THE Institute of Medicine of Chicago has received from an anonymous source $10,000 which will be known as the Joseph Almarin Capps Endowment Fund.

CORNELL UNIVERSITY has received another anonymous gift from the anonymous donor who last year sent a cashier's check for $20,000 and requested that no effort be made to discover his identity. This time the check was for $10,000, to be used for the engineering college.

EIGHT fellowships for the training of leaders in forestry have been awarded for the year 1930–31 by the Charles Lathrop Pack Forest Education Board, and the board is preparing to receive applications for fellowships for the year 1931–32. The fellowships already granted cover a wide range of practical and theoretical forestry, including reforestation, management of private forest estates, cooperative marketing of forest products, silvicultural management and forest pathology. Six to eight fellowships, with stipends ranging from $500 to $2,500, are available for the coming year. Their purpose is to encourage men who have shown unusual intellectual and personal qualities to obtain training that will best equip them for responsible work, either in the general practice of forestry, in the forest industries, in the teaching of forestry, in forest research or in the development of public forest policy. Applications will be received not later than January 15, 1931. Application forms and detailed announcements can be obtained from Ward Shepard, Secretary of the Charles Lathrop Pack Forest Education Board, 1214 Sixteenth St., N.W., Washington, D. C.

THE Board of Estimate of New York City has accepted the offer of Mr. John D. Rockefeller, Jr., to

give the city the fifty-six-acre Billings estate on Washington Heights, to be used for park purposes, in return for the closing of East Sixty-fourth and East Sixty-eighth Streets, between York Avenue and Exterior Street, for the respective purposes of expanding the Rockefeller Institute and the erection of the New York Hospital. The city will receive land with an assessed valuation of $2,000,000 and in return will give up land with an assessed value of only $300,000. It is estimated that additional work will cost Mr. Rockefeller about $2,065,000, against the city's $700,000.

FINAL proceedings in the acceptance of land tendered the United States Government by the governors of North Carolina and Tennessee to constitute the Great Smoky Mountain National Park have been completed, according to an announcement of the Interior Department. Titles to the land have been formally passed on by the attorney-general and the government has announced its acceptance. The tract given by the two states covers an area of 158,876 acres and will form a nucleus for a park with a minimum area of 427,000 acres. Under the act of Congress authorizing its establishment, the park may be extended to include over 700,000 acres. The Great Smoky Mountain National Park will have roads and trails, being planned like the western parks, and will be divided equally between North Carolina and Tennessee. A great mountain range will carry the border between the states. The act under which the park was established provided for donations of land in order to reach the full status. Other eastern parks which have been authorized by the Congress and which are awaiting receipt of land are the Shenandoah National Park in Virginia and the Mammoth Cave project in Kentucky.

A START on the elimination of private lands in Glacier National Park has been made with the acceptance by the Department of the Interior of deeds to approximately 140 acres of land at the foot of Lake McDonald, not far from park headquarters. Altogether about sixty per cent. of the land in this area has been acquired or is in process of acquisition. These acquisitions will simplify park administration and will also make possible the remedying of unsightly conditions that have prevailed around the foot of the lake. An allotment of $198,000 of government funds was used in arranging for the consummated and pending acquisitions.

SIR J. J. THOMSON, as president of the Association of Special Libraries and Information Bureaus, writes to the London *Times* to draw attention to the formation by the association of a panel of expert translators. He says that those who require the services of a translator often experience difficulty in finding one who has both a knowledge of the language and also of the special subject concerned, and the difficulty increases where the language is uncommon and the subject highly technical. Proficiency in the language is not enough. To afford specialized service the translator must have not only a good knowledge of the language, but a really close acquaintance with the subject he has to translate—*e.g.*, the law, metallurgy, medicine, architecture, management, or whatever the subject may be. With the object of overcoming this difficulty, which has been brought to their notice continually, the council of the association recently appointed a committee consisting of Dr. S. C. Bradford, librarian, the Science Library; Allan Gomme, librarian, the Patent Office; Dr. R. S. Hutton, director, British Non-Ferrous Metals Research Association; Miss A. L. Lawrence, Intelligence Officer, British Medical Association; Brigadier-General Magnus Mowat, secretary, Institution of Mechanical Engineers; E. I. Robson, librarian, Institute of Agricultural Engineering, to prepare a scheme for establishing a panel of translators having both linguistic and technical qualifications, the part taken by the association being to act as a connecting link between the translator and the user. Names of approved qualified persons are now being registered.

DISCUSSION

DISCONTINUANCE OF THE LA JOLLA PEROMYSCUS PROGRAM

THE studies of geographic variation and heredity in mice of the genus *Peromyscus*, which have been conducted by the writer and his assistants at La Jolla for more than sixteen years, have recently been discontinued. These studies were commenced early in 1914, under the auspices of the Scripps Institution for Biological Research of the University of California. Owing to a radical change of program and of policy, some eight or nine years later, in accordance with which the Scripps Institution for Biological Research was finally transformed into the Scripps Institution of Oceanography, the continuance of such studies at the La Jolla station became anomalous. It was inevitable that the *Peromyscus* program should either be transferred to some other establishment or be discontinued altogether.

Since these studies were (and I think still remain) the only serious attempt which had been made to analyze geographic variation, in either mammals or birds, by precise quantitative methods, and particularly to determine the genetic status of subspecific characters, it was thought by many that they ought

not to be terminated merely as an incident in a change of administrative policy. This view was concurred in by Dr. Vaughan, at the time of his succession to the directorship of the Scripps Institution, and the *Peromyscus* studies were continued for some years after the institution had adopted an otherwise exclusively oceanographic program. But such an anomalous situation could not be expected to continue indefinitely. As an emergency measure, the Carnegie Institution of Washington came to the rescue in 1927, in order that results already obtained or material already at hand might be utilized to the fullest. The liberal contribution then made by the Carnegie Institution permitted not only of full utilization of previous data and material, but made possible considerable further progress with the work. The funds which were contributed for the purpose, however, are now exhausted.

Despite past and recent efforts by the administration of the University of California, it has proved to be impracticable to transfer this program of research to Berkeley, and to have it conducted under the auspices of any university department there. Such a time-consuming research program is naturally incompatible with one's carrying an even moderate teaching schedule, particularly if one's teaching experience has been limited.

For these reasons, the *Peromyscus* program, at least so far as the present writer is concerned, has been brought to a close. In its place, studies will be undertaken of the ecology and possibly the genetics of certain species of fishes, both fresh water and marine. Certain of these studies are already in progress. The remaining stock of *Peromyscus,* comprising seven subspecies, has been sent to Dr. Lee R. Dice, of the Zoological Museum, University of Michigan.

That university is the only one, so far as I know, in which experimental breeding operations are being conducted in connection with its museum of zoology. It is to be expected that other universities will, in time, recognize the wisdom of such a policy.

It has seemed desirable to issue the foregoing statement, owing to misunderstandings which have prevailed for some years regarding the status of the investigations in question and the writer's connection with the Scripps Institution. I will conclude by saying that reprints of papers, including those on genetic subjects, will still be welcomed by the writer at the same address.

F. B. SUMNER

SCRIPPS INSTITUTION OF OCEANOGRAPHY

PHYSICOCHEMICAL PHENOMENA IN THE ANTARCTIC

THE paper of Rear Admiral Richard E. Byrd entitled "The Conquest of Antarctica by Air" published in the August number of the *National Geographic Magazine* brings out several facts which are not only of general scientific interest but are also of particular importance to those who have to deal with low temperature conditions, *e.g.,* aviation and pilot balloon investigations.

The influence of intense cold on chemical reaction appeared when he was examining a crevasse while the temperature was *only* 50 degrees below zero (presumably F.). Byrd writes: "We could not use hand flashlights, because the cold stopped the chemical action of the dry batteries. We provided light by linking a portable gasoline engine generator to a locomotive-type searchlight pointed down the dark fissure." When the thermometer was 71 degrees below, they had to warm the candles used under the meteorological balloons before they could be lighted.

The ready formation of finely dispersed (presumably colloidal) ice is shown by the following: "It was amazing to see fogs at these temperatures. The air holds a very small amount of moisture at 50 below, but when the wind stirs the warmer and the colder air condensation of this minute amount of moisture occurs and a real fog is evolved. . . . Even a book lying against a cold wall steamed like a teakettle when opened in a slightly warmer atmosphere. When a man stood inside the entrance to one of the house tunnels, the vapor formed by his breathing was so heavy the house appeared to be on fire." Water in the form of colloidal ice seems to be the cause of so great an effect from so small a quantity.

Some peculiar physical effects may be noted. At 64 below, "It was so cold that when a man stood outside the tunnel he could hear his breath freeze. The condensation caused a faint swishing sound like snow blown across the ice surface by a strong wind." Kerosene froze solid. "One mid-July day the mercury touched 71 below zero. That caused the barrier snow to contract sharply. All about us we could hear the ice snapping and cracking. Then, as large cracks occurred, the bay ice began booming like distant guns. The guy wires on the antenna posts became as taut as harp strings and the wind played odd humming tunes on them."

In order to avoid dangers following failure of soldered cans, which Dr. B. T. Brooks pointed out as due to formation of gray tin ("tin disease") at low temperatures, the supplies (oil, gasoline, etc.) were packed in copper cans made with silver solder.

JEROME ALEXANDER

CIRCULAR SHADOWS FROM VORTICES

YESTERDAY while I was sitting in the bright sunshine on a rock in the middle of the Croton River my

attention was called to circular shadows on the rocks and the bottom of the stream. These shadows varied in size from about one inch to one and one half inches in diameter. Around the outer edge of the shadows was a halo and occasionally faint rotating streamers.

The water was quite clear and it was perfectly obvious that floating objects were not responsible for the shadows. It was observed that the shadows came from vortices and, further, that these vortices depressed the surface in such a manner that the light, falling in the vortex, was deflected outward somewhat, as in the concave lens.

This is simply one of those interesting phenomena which I never happened to observe previously. I am thinking that perhaps others who read this may find one additional thing to look for when they are in the open.

F. C. BROWN

MUSEUMS OF THE PEACEFUL ARTS
NEW YORK, N. Y.

PLANETARY SYSTEMS

IN his retort to Professor Porter, who had criticized him for saying that planets like those of the solar system are rare, though there are millions of stars more or less similar to our sun, Professor Arthur H. Compton seems to feel that he fully justifies his position by citing as his authority the distinguished theoretical astronomer, Sir J. H. Jeans.

Doubtless Professor Porter overstates his case in claiming that "there is absolutely no reason for the assumption that the formation of attendant worlds may not be the ordinary course of evolution for the single stars." On the other hand, it must be recognized that Jeans's conclusion is based upon highly theoretical assumptions and should not be given too much weight. It is to be feared that Professor Compton has erred in asking his readers to accept as a demonstrated fact what is in actuality little more than an educated guess.

G. B. BLAIR

UNIVERSITY OF NEVADA

SCIENTIFIC BOOKS

The Size of the Universe: Attempts at a Determination of the Curvature Radius of Spacetime. By DR. LUDWIK SILBERSTEIN. viii + 215 pp. Oxford University Press, London, 1930.

THE problem of the curvature of space was born directly out of the relativity theory of gravitation and was therefore first raised seriously by Einstein, who was led to adopt as a basic geometry of the universe one of constant curvature in space, leaving the time coordinate "straight." De Sitter, on the other hand, contemplated another possibility, in which the four-dimensional world is perfectly spherical, the time being curved along with the space coordinates. These two possibilities are generally referred to as Einstein's cylindrical world and de Sitter's spherical world, and they fairly exhaust the worlds of constant curvature.

Does our own world belong to the class of constant curvature, and, if so, is it of the cylindrical or the spherical class, and what is the actual value of its radius of curvature? These are the questions Dr. Silberstein sets out to answer.

The first part of the book is concerned with the general theory of curved surfaces, the theory of tensors and the relativity theory of gravitation. The second part is devoted to a discussion of the relative merits of Einstein's and de Sitter's worlds. The third part contains an extensive, and rather unexpected, criticism of Dr. Hubble's estimate of the world radius corresponding to Einstein's cylindrical world. The fourth and fifth parts are concerned with the Doppler effect in de Sitter's world and how this may be used to find the world radius from an analysis of the radial velocities of the stars. This latter problem is also the subject of miscellaneous notes at the end of the book.

The reader is likely to finish this book in a state of mingled admiration and depression. Its every page bears witness of a strong personality, and the formal style is unusually clear and attractive. The introductory chapter on non-Euclidean geometry is, in particular, a product of fine, artistic beauty. On the other hand, the book is written exclusively from Dr. Silberstein's personal point of view, and as this frequently runs opposite to the opinion of other authorities the reader will have to do a lot of reading in the general literature in order to be fully informed on the subject. For an astronomer it is especially disconcerting to read the last part and the notes. In fact, to search for the de Sitter-Doppler effect in the motion of the nearer stars seems, to put it mildly, like hunting for a needle in a haystack. Considering that in this search much more pronounced peculiarities in the laws of stellar motion have been sacrificed, Dr. Silberstein can scarcely blame the astronomers for having little faith in his results.

So much has been written about the curvature of space, both in scientific journals and in the press, that a separate book on the subject should meet with general approval. The present book seems more calculated to stimulate than to satisfy this demand. This may be fortunate, as, according to some recent

work of Abbé le Maître and of Eddington, the problem may be more complicated than was believed previously. In fact, the universe may, perhaps, not at all possess a constant world curvature; and it must be admitted that the preponderantly positive radial velocities of the spiral nebulae are most simply explained by assuming the whole universe to expand, and to have nothing to do with the de Sitter-Doppler effect.

On the whole, the subject of the curvature of space is one in steady progress, the present state of which does not encourage to any display of orthodox convictions, but which may become of considerably more cosmologic importance in the near future.

SVEIN ROSSELAND

OSLO UNIVERSITY OBSERVATORY

Determination of Orbits of Comets and Asteroids. By RUSSELL TRACY CRAWFORD. xi + 233 pp. McGraw-Hill Book Company, 1930.

A TEXT-BOOK designed for a college course of one semester to provide an introduction to the subject of orbit determination. The following subdivision of the book could be made: (*a*) Introductory chapters treating the motion of a body about the sun as attracting center, also including the subject of ephemeris computation; (*b*) Leuschner's method of orbit determination; (*c*) Merton's modification of the Gaussian method of orbit determination. Completely worked out examples and summaries of formulas for both methods and fourteen auxiliary tables are added.

As the author states in his preface, this work is different from other treatises on orbit computation. It is not intended to be complete, and does not, for instance, include the mathematical development of precession, nutation, special perturbations or least squares. "The definitive orbit" is very briefly treated, but logically, considering the fact that the book treats undisturbed orbits only.

Notwithstanding limitations set by the scope of the book, it is complete enough to be a very useful reference book. Those interested in more intricate problems, mainly of theoretical importance, which could not be fully treated, will find many helpful references to original publications.

This is the first time that a coherent presentation of Leuschner's method is published, after the original publication in Vol. VII of the Lick Observatory Publications. (Buchholz-Klinkerfues, 1912, gave little more than a set of formulas and examples.) Especially because many treatises on orbit computation entirely disregard the existence of other methods than the Gaussian we could have been satisfied with a book presenting Leuschner's method only. The fact that two methods, one representing the Laplacian and the other representing the Gaussian method, are given testifies to the broad attitude taken by Leuschner and his followers.

That Merton's development of the Gaussian method is chosen is not surprising. It has done away with a number of complications mainly due to the former necessity of adapting all formulas to logarithmic computation. The two methods offered are undoubtedly distinguished by theoretical clearness and adaptation to practical needs.

It would have been impossible within the scope of the book to include a critical comparison of methods of orbit computation. This is left to the student. The field which this book covers is very large, so that a selection was necessary. The author has made an admirable choice guided by his expert knowledge of the subject and experience in teaching it.

The book is beautifully printed; one can only wish that the subdivision of the chapters had been made more uniform and more distinct. The generous size of the pages (10 x 7 inches) has contributed much to its fine appearance, as many long formulas had to be included. The book is dedicated to Professor A. O. Leuschner, "a most stimulating teacher and inspiring director."

DIRK BROUWER

YALE UNIVERSITY OBSERVATORY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN OBJECTIVE METHOD OF EVALUATING MUSICAL PERFORMANCE

IN the psychological laboratory of the University of Iowa we have developed instruments which enable us to record actual singing and playing accurately and quickly. This is done mainly with the strobophotograph camera designed by Professor Milton Metfessel[1] and recently improved by Tiffin and Reger. It virtually graphs two of the four elements of musical performance, namely, pitch and time. The other two elements, intensity and timbre, are not recorded.

A stroboscopic disk runs between the film and a neon lamp. The lamp flashes in frequency with the sound wave, and the film, moving past at a constant speed, registers a continuous picture of the stroboscopic effect.. The stroboscope registers in terms of tenths of a tone but finer readings may be made in proportion to the steadiness of the tone.

The object of this note is to illustrate how this

[1] *Jr. Gen. Psychol.*, 2: 135–139, 1929.

method may be used in evaluating the singing or playing of an amateur as compared with a professional singer; or, for that matter, any comparison of two singers or players.

Figs. 1 and 2 are records in the scientific musical notation called the "pattern score" showing the rendition of "The Last Rose of Summer" by an amateur whom we shall call "Helen" and by Frances Alda, respectively. Assuming that Alda is a good representative of an artistic singer and that Helen is a promising amateur whose performance we wish to compare with a recognized artist, we may compare in detail the performance of the amateur with the performance of the recognized artist.

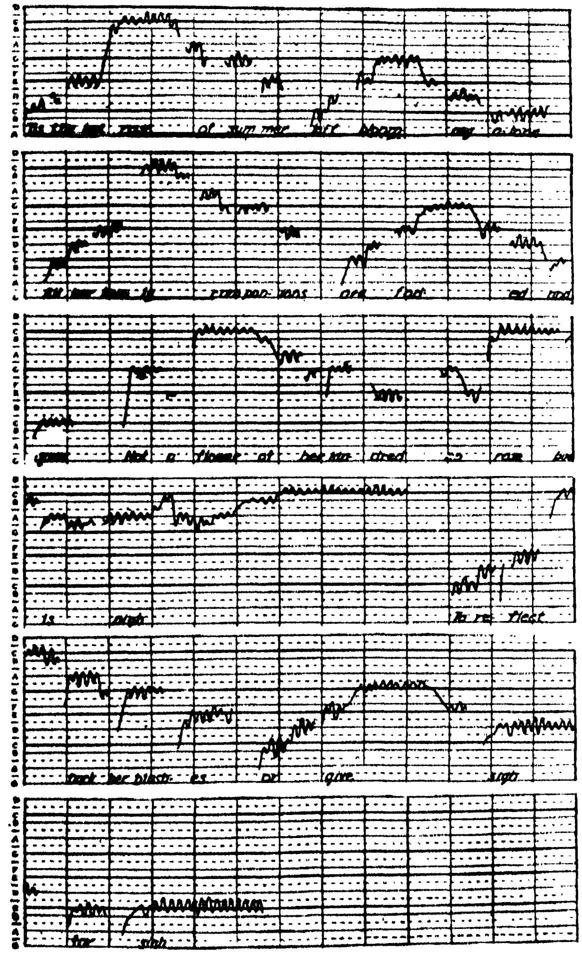

FIG. 1. "The Last Rose of Summer" as sung by an amateur "Helen."

Intonation is indicated in minute detail in the form of a graph for each note, showing in exact detail what was actually sung, as to pitch and time. The vertical lines divide the staff into seconds; the notes are indicated in the margin at the left; the solid lines indicate the white keys and the broken lines the black keys. The oscillations in the graph for each note show the character and extent of the vibrato.

One is struck with the great liberty that the artist takes with the conventional musical notes. Presumably the beauty in the rendition lies in the artistic deviation from the conventional notes, both as to pitch and time. It may be noted that these deviations from the true intonation are seldom heard in their true extent, even by the ear of good musicians, because we have the habit of apperceiving music in terms of the conventional notation. At any rate one who is not familiar with the objective analysis of singing, such as here given, is surprised to find the artist deviating so greatly from the musical notation.

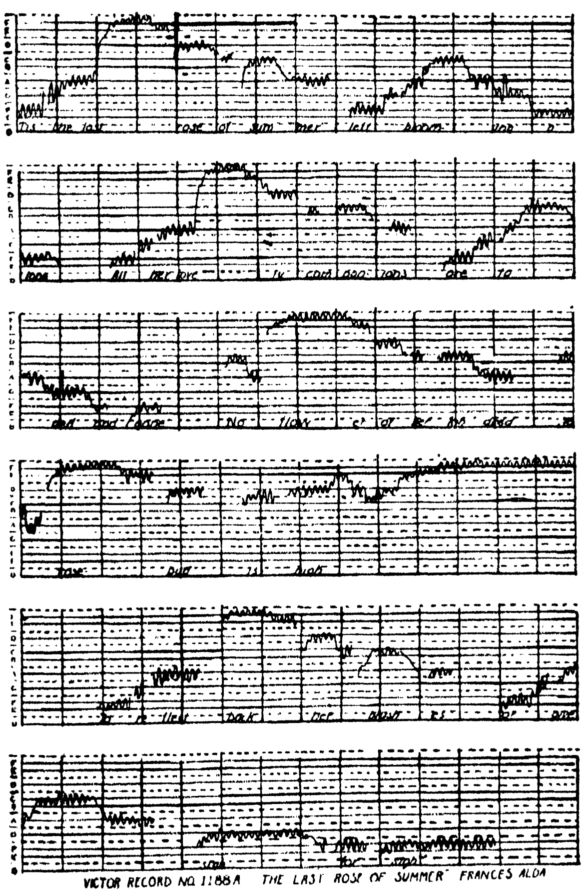

FIG. 2. "The Last Rose of Summer" as sung by Frances Alda.

Now to evaluate our amateur singer we may at once make comparison of the relative duration and intonation of each tone throughout the selection, and the division of emphasis. We may then consider each note in detail: (1) as to the mode of attack; (2) as to the mode of release and transition; (3) as

to duration; (4) as to the mean pitch, the pitch actually heard tending to be approximately 6 per cent. of the extent of the vibrato below the center of the oscillation; (5) the vibrato, considering such facts as number of pulsations per second, the amplitude in pitch (each horizontal space representing a semitone), and regularity of the vibrato, and (6) the occurrence of mordents, as on the last syllable of "blooming" and the last syllable of "faded" by Alda. Numerous measures of subordinate elements for each of these factors may be made. Of special interest is the mode of glide, particularly within the tone itself, as on the words "the last" by Alda.

Here a single artist is taken as an example of a good singer. There are, of course, great differences among good artists; multiplying of illustrations brings out these features. We here simply wish to illustrate the principle.

In interpreting the relative performance of the two singers we must fall back upon a gradually accumulating series of norms which we are now building up for all these factors. For example, Helen's vibrato, which averages about five pulsations per second, is somewhat too slow as rated by our norms for artists. Alda's rate of about seven pulsations per second is approximately the most favored rate. On the other hand, the amplitude of Helen's vibrato is not quite as large as Alda's, or as the norms for artistic singers in general. This may or may not be in her favor. One of the writers is of the opinion that it is decidedly in her favor because the more subdued the vibrato the more pleasing it is to him.

But such subjective differences of opinion may now be gradually eliminated by two different processes: first, by measuring agreement in practice among the great artists; and second, by determining the best achievement of such artists under experimental control and submitting these to experimental analysis and evaluation from the point of view of experimental esthetics. This procedure of giving recognized artists the opportunity of perfecting performance with the aid of measuring instruments under fractionated procedure is the avenue through which we shall ultimately establish norms of artistic achievement.

When the other two factors, intensity and timbre, are recorded with the camera and added to our scientific musical score of performance, we shall have a comprehensive objective basis for the comparison of musicians and for the detailed quantitative account of musical value.

Carl E. Seashore,
Joseph Tiffin
University of Iowa

SPECIAL ARTICLES

THE TREATMENT OF PATIENTS WITH ADDISON'S DISEASE WITH THE "CORTICAL HORMONE" OF SWINGLE AND PFIFFNER

The preparation of an aqueous extract of the suprarenal cortex which would maintain the life of bilaterally suprarenalectomized cats indefinitely was announced by Swingle and Pfiffner in a brief article published in Science of March 21, 1930. Subsequently they have reported that by the administration of this extract they were able not only to revive comatose animals, on the verge of death from suprarenal insufficiency, but also to restore them to a normal condition and to keep them in perfect health by daily injections.

The significance of such an announcement and the interest aroused by the possibility of using this extract in clinical medicine are obvious. An extensive experience in the use of the so-called Muirhead regimen in cases of Addison's disease has convinced us of the futility of ordinary therapeutic measures in combating the crises of acute suprarenal insufficiency which develop in the course of this disease and of the great need for a more active cortical preparation which can be administered either hypodermically or intravenously. This point was further emphasized by a patient with Addison's disease who was brought to the hospital in a state of complete collapse, May 31, 1930. The outlook seemed hopeless under ordinary conditions, but as a last resort a telegram was sent to Drs. Swingle and Pfiffner and they forwarded a supply of cortical extract by air mail. The patient, who was in a state of typical collapse, was restored to activity within two to three days. A summary of the clinical history in this case follows:

The patient was a farmer, aged thirty-nine years, and first came to the clinic in January, 1930. He had had pleurisy with effusion eleven years previously and symptoms of Addison's disease had been present for eight months. He was in a critical state when admitted; he was in collapse, the systolic blood pressure was 78 mm of mercury, and the blood urea 48 mg for each 100 cc. Treatment was given with solutions of sodium chloride and glucose intravenously, and the Muirhead regimen was instituted. The patient improved slowly; he was dismissed from the hospital thirty-nine days after admission.

Progress at home on the Muirhead regimen was satisfactory for a while, but the patient was brought back to the clinic in a state of collapse, May 31. Treatment

with solutions of sodium chloride and glucose was instituted again, with only partial success. The extract of the suprarenal cortex sent by Drs. Swingle and Pfiffner arrived on the sixth day after the patient's admission to the hospital and treatment was begun with daily doses of 20 cc given subcutaneously. Within thirty-six hours a marked effect on appetite and strength was apparent. The patient, who had been so nauseated as to retain water with difficulty, now asked for wieners and sauerkraut and in lieu of the latter ate a double order of beefsteak with relish.

This extract produced considerable local irritation at the site of injection and because of the content of epinephrine could not be given intravenously in therapeutic doses. A further supply of the extract was not available at that time; therefore the patient was put back on the Muirhead regimen. He did well for a few weeks, but gradually failed and again went into collapse, from which the timely arrival of a fresh supply of extract sufficed to insure temporary recovery.

This cycle has been repeated three times in this case. The last time it was possible to use Swingle and Pfiffner's newest extract, which is free from epinephrine. This was given intravenously in divided doses in a quantity of 20 cc daily with a total dosage of 50 cc. Before its use the patient was excessively weak, bedridden, depressed, nauseated, losing weight and showed evidence of failing circulation. Within forty-eight hours he had taken a new lease on life, his appetite was excellent, his strength was greatly improved and he appeared to be in a state of perfect health. He gained 9 pounds in weight in the next eight days and has been in good condition since then.

Since that time it has been possible to observe the effect of the preparation on three other patients suffering from Addison's disease. The condition of one patient was not considered serious at the time of his examination and he was kept on the treatment for only four days. There were no spectacular changes during this period and the small supply of extract precluded its further trial. In the other two cases the clinical condition of the patients and the results obtained by treatment were similar in character to those observed in the first case. Metabolism studies were made in one case during the period of observation. The results will be reported later, but preliminary observations indicate disappearance of creatinuria and retention of nitrogen in consequence of the administration of the suprarenal extract.

The results in these cases convince us of the apparent efficacy of this cortical extract. There was no striking change in the blood pressure, but the disappearance of anorexia, increase of appetite to the point of hunger, the gain in weight and the definite feeling of increased strength and well-being were striking. As long as the preparation was administered, the results were all that could be desired. However, our supply of the preparation has been limited, so that we have not been able to observe the results following consistent dosage and continued administration. The first preparation was not free from epinephrine and caused local irritation when given subcutaneously. The later supply, however, is almost free from epinephrine; it is suitable for intravenous administration and is almost non-irritating locally. As has been shown, the immediate results in a crisis were excellent. Addison's disease, however, is chronic, and it will be necessary for several years to elapse before a final appraisal can be made of the value of this new therapeutic agent in its treatment.

LEONARD G. ROWNTREE
CARL H. GREENE
DIVISION OF MEDICINE,
THE MAYO CLINIC,
ROCHESTER, MINNESOTA

THE suprarenal cortical extract used intravenously by Dr. Rowntree on patients with Addison's disease represents the modification of our original aqueous preparation mentioned in an earlier communication to this journal.[1] This extract, 1 cc of which represents 30 gm of fresh beef cortex, contains only 0.3 per cent. of solids. The epinephrine content as measured by blood pressure assay on dogs is at most between 1:1,000,000 and 1:2,000,000. The method of fractionation used is based on our observation that, by the proper use of permutit, epinephrine can be practically quantitatively separated from the cortical hormone. The 70 per cent. alcohol-soluble fraction obtained by our previously described method[2] is simply filtered in alcoholic solution through an adequate amount of permutit which removes the epinephrine. Much inert material including most of the contaminating pigment is also removed by this fractionation step.

W. W. SWINGLE
J. J. PFIFFNER
PRINCETON UNIVERSITY AND
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COLD SPRING HARBOR, L. I.

ON THE CHEMICAL ALTERATION OF PURIFIED ANTIBODY-PROTEINS

DIAZONIUM salts of well-defined chemical compounds coupled to proteins have been used in the study of the relation of biological specificity to chemical constitution, in particular by Landsteiner[1] and his co-workers in the last two decades. It has usually been found that the coupled compound fully determines the

[1] SCIENCE, 72: 75–76, 1930.
[2] SCIENCE, 71: 321–322, 1930.
[1] Landsteiner and Lampl, *Biochem. Zeitschrift*, 86: 343, 1930.

specificity of these proteins as antigens, but some experiments have been published in which the original biological specificity of the proteins also remains.[2]

It would seem possible, therefore, to alter chemically with the same methods such substances as display a specific biological activity without destroying this latter quality. This process appeared to us of special interest in the case of animal proteins, which play an important rôle in pathology because they carry the immune properties of the animal body, namely, the antibodies. The antibodies have a specific affinity towards their antigens (pathologic bacteria) but they usually do not destroy them or do not even lower their resistance enough to permit them to be phagocytized. We thought that in some instances a chemical alteration of the type mentioned above might increase the destructive effect of antibodies on pathogenic antigens and convert these antibodies into a quasi specific disinfectant or chemotherapeutic agent. We are attempting to obtain such an effect by introducing groups to change the physical properties of the immunebody-carrier proteins, or groups which are known to possess disinfecting or chemotherapeutic activity, or known to be apt to increase the disinfecting power of organic disinfectants.

Experimental work along this line was started in these laboratories some months ago, and without knowledge of the somewhat similar experiments and results which were recently published by Bronfenbrenner.[3] In view of the accordance of our findings (with respect to the fact that chemical alteration, if carefully conducted, does not destroy immune properties) with his (presumably using different agents) a preliminary report upon some phases of our work would seem to be in order.[4]

In certain of our experiments para-aminophenylarsonic acid (atoxyl) was used for diazo-coupling because of its activity as a chemotherapeutic agent in certain protozoan diseases. The antibody protein was a Type I and II pneumococcus antibody, for this can be prepared in a comparatively highly purified state and its strength can be measured more easily than that of any immune serum produced against a protozoan parasite. The diazotization was carried out in the usual way. However, the pH was not allowed to change during the whole process of coupling more than from 5.0 to 7.5, approximately. A product resulted which was almost insoluble around its isoelectric point at pH 6, and soluble to a dark brown solution at neutral or alkaline reaction, soluble with a light yellow color on the acid side of the isoelectric point. This "antibody-dye" could easily be reprecipitated by dialysis and adjustment of pH. On carrying out the process in the same way a second time, identical products were apparently obtained, the As_2O_3/N ratio being in one case 0.028, in the other 0.027. If the products were taken up in the same volume of physiological saline as the original, agglutination was observed up to the same dilution as with the original antibody preparation (1/320). A very marked prezone was found, which was not present in the original preparation. Mice infected with 100,000 lethal doses of virulent pneumococci could be protected fully, *i.e.*, cured with 0.2 cc of the preparation containing respectively 6.6 mg N and 0.18 mg As_2O_3, and 7.5 mg N and 0.2 mg As_2O_3 per cc, when injected intravenously, simultaneously with the infection, or 4 hours after, or 20 hours after the infection. Normal horse serum-globulin coupled with atoxyl had almost no effect. It is also interesting to note that 0.5 cc of the original antibody solution killed mice almost instantly when injected intravenously, whereas the same amount of the coupled product had no effect.

Finally, we also note that the introduction of the easily detectable arsenic into the antibody-carrier protein is helpful for quantitative study of the degree of purification of antibodies, as well as quantitative study of the antibody reaction. Further experiments are in progress.

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NEW YORK UNIVERSITY

[2] A. Klopstock and C. E. Selter, *Zeitschrift für Immunitäts.*, 55: 118, 1928; M. Heidelberger and F. E. Kendall, *Proc. Soc. Exp. Biol. Med.*, 26: 482, 1929.

[3] Bronfenbrenner, *Proc. Soc. Exp. Biol. Med.*, 28: 734, 1930.

[4] Bronfenbrenner's object in starting his experiments was different from the above. He wanted to deprive immune sera of their original biological specificity in order to avoid anaphylactic shock at repeated injections of sera derived from the same species.

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CHEMISTRY AND EDUCATION[1]

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NEARLY a century and a half has passed since chemistry was first recognized as a subject worthy of study in our colleges. Maclean in his "History of the College of New Jersey" states that this college as early as 1795 included chemistry among the subjects for the study of which provisions were made. Other reputable universities of that day soon followed, and early in the last century chemistry was a required study in the course in liberal arts at Columbia, Harvard and Princeton. This new-born infant, however, was not received with any great cordiality into the family of studies that had long constituted the essentials for the baccalaureate degree. Its growth was impeded in many ways, and there were times when there was some fear as to whether it would survive the rigors of doubt and suspicion to which it was exposed. Years were to pass before laboratory work was offered as an essential part of the course, and even then in some of the colleges, at least, the students electing laboratory work were regarded with suspicion as to their sanity. They were thought by some of the classicists to be allied with the alchemists of old, who sought in secret places to transform the baser metals into gold, or to discover that mystic something that would bring perpetual youth to its fortunate possessor. Gradually the science won its way, even though there were few students and the library and laboratory facilities were very meager. The following quotations taken from the reports of the professor of chemistry, fifty years ago, in a university that to-day has a laboratory costing more than $1,000,000, adequately equipped, and with an enrolment of 3,000 students in the department of chemistry, will serve to give us some insight into the conditions for studying chemistry at that time:

Five students took the course in general chemistry; in analytical chemistry we have two students, one of

[1] Address of the president of the American Chemical Society, Cincinnati, September 10, 1930.

whom is ready to begin his course in quantitative analysis. . . . At present the chemical library of the University consists of Watt's Dictionary—a valuable work, but not fully supplying our needs . . . we have begun to take a chemical journal. . . . A Chemical Hall is needed with which also the mining and metallurgy could be associated. This need not be an expensive structure; for $20,000 a building could be erected that would provide ample room and the very best facilities for carrying on these important departments.

Evidently in those days as in the present not all the students were adequately trained, for we read:

I regret to add that the class is hampered by a few students who are not well prepared for the work. It is probable that some, if not all of these ill-disciplined pupils will fail to pass their first examination.

Janitorial troubles there were in those days, even as at the present time, for we read again:

Each laboratory, in addition to its hood has four flues that must remain open whatever may be the theories or the practices of the janitor. It has, also, subject to the will of the janitor, an opening extending the whole length of the ceiling and open to the sky.

But a great change has taken place. Opposition to the study of science gradually gave way, and interest grew apace, so that the present century and especially the last decade has witnessed a growth in the appreciation of chemistry and in the provisions for its study in our schools and colleges far beyond any expectations. Laboratories, a number of them costing in excess of $1,000,000, have been built and furnished with all the equipment necessary for instruction and research. The enrolment has increased correspondingly. In the twenty-nine universities belonging to the Association of American Universities, there were registered in one or more courses of chemistry during the last year more than 25,000 students. According to the statistics compiled by Mr. C. J. West, of the National Research Council, the number of graduate students engaged in research in the various fields of chemistry increased from 1,700 in 1924 to 2,498 in 1929. Of this latter number, 1,200 were candidates for the master's degree and 1,298 for the doctor's degree. A recent bulletin published by the Federal Office of Education lists statistics of more than 1,000 colleges and professional schools. Counting but an average of 50 students in chemistry in each of these (a very conservative estimate) the number of students of chemistry in these institutions exceeds 50,000, to say nothing of the large number of such students in our secondary schools.

Many causes have operated to bring about this growth in the appreciation of our science. The great industrial development of recent years has created an unprecedented demand for trained chemists, a demand reflected in the number of students electing chemistry as their major course. The war made vivid the possibilities of our science and led to an increased willingness to provide adequate facilities for its study.

But along with these factors is another, which, I fear, teachers of chemistry absorbed in their work have been slow to recognize. I refer to the new views regarding education and the educative process. We are living in a rapidly changing world. Those of us at all mature in years have witnessed the unearthing of fundamental knowledge such as no other generation has ever witnessed and, some would say, more than have all other generations together. It was only about thirty-five years ago that Thomson first found conclusive evidence of the existence of the electron; indeed, most of us recall the time when the atom was regarded as a single indivisible particle, true to its name. Following closely on the discovery of the electron came the X-rays. The invention of the radio and of wireless communication is well within the memory of the youngest of us. The Wright brothers flew their first airplane on the sand hills near Kitty Hawk, North Carolina, in 1903. Automobile statistics list in 1896 only four gasoline auto cars in this country; one of these was in a museum, and another wouldn't run. To-day there are 25,000,000, and in place of going miles to see one, as I recall doing, we must watch our step to avoid one.

Along with this rapid growth in knowledge of our science and in its application to useful ends has come also a growth in appreciation of the value of education and a desire to share in its advantages. The number of students in our high schools increased from 500,000 in 1900 to 4,500,000 in 1930. In the same period the registration in our higher institutions of learning (colleges, universities and professional schools) has increased from 250,000 to 1,000,000, while more than 50,000 students are registered in our graduate schools alone. We have often heard the statement that the great teacher is born, and not made, yet to-day we find colleges of education on every hand, and we hear much of "teacher training." Adult education is coming to the fore, and even the air is filled with college courses. One has only to press the right button to bring to one, offhand, a course in almost any desired subject. Our whole nation is, indeed, going to school.

This increasing appreciation of the value of education has been accompanied, and naturally so, with much discussion as to the aims of education and the most efficient methods for obtaining the desired ends. Educational organizations of all kinds have been formed, new journals dealing with educational prob-

lems have sprung into existence, new ideas are being tested and the curricula of our schools and colleges are being modified to accord with our modern ideas. Bureaus devoted entirely to research in the field of education are finding a place in our universities, and to-day one hears almost as much about educational research as about chemical research.

Many of us, at least, have been suspicious of the modern emphasis upon methods of teaching as likely to overpower attention to content, fearful that popularization might stifle the spirit of mastery and investigation. Naturally, among the many presentations of ideas, some will appear beside the mark—even nonsensical. But it will not do for us to dismiss all this discussion with a mere wave of the hand as the lightly spun and passing theories of those who might well be engaged in something more worth while, something, we might say, more scientific and less philosophical. To ignore the writings in the field of education to-day of such thinkers as Dewey, Whitehead, Eddington, Bode, Barry and others is a reflection not upon these great scholars, but upon ourselves.

For we must keep in mind that the members of the instructional staff of the departments of chemistry in our colleges and universities are not only chemists, but teachers as well. The teacher of chemistry should be just as much concerned with what is new and of value in the theory and aim of education as the teacher of psychology or of English. Interest in research should not diminish interest in teaching. It sometimes seems to me that our appreciation of the teacher is declining. One of the most difficult positions to fill in our departments of chemistry to-day, and to my mind one of the most important, is that which has to do with guiding the instruction of the students in the basic introductory course. Men adequately trained in chemistry more and more seem to think it beneath their dignity to have anything to do with the beginner, apparently forgetful of the fact that the great chemists of all times regarded the introductory course as being of so much importance that they were unwilling to trust it to any one other than themselves.

As to methods of instruction, I confess that if by method one means order of presentation, proportion of lecture to quiz, etc., etc., I have never been able to become enthusiastic over their importance. But if by method is meant such an ordering of classroom and laboratory as will develop in the student alertness, mastery, self-guidance and the reseach spirit, then method is important; there must be certain fundamental principles underlying all successful methods of teaching, important and worthy of study, and teachers apparently brilliant may fail of results because of lack of them.

But whatever may be the facts concerning the value of the study of methods, there certainly can be no doubt as to the value of the study of the aims of education; for if we are to do effectively we must have a very definite and clear-cut idea as to what we are attempting to do. It is especially essential that teachers of chemistry be familiar with the best thought of the day concerning the aims of education. For, to a constantly increasing extent, chemistry is taking its place as one of the fundamental subjects included in the liberal arts curricula of our colleges. All evidence points to a constantly increasing appreciation of the value of our science as a constituent of these curricula. "More and more," says a writer, "science will find its way into our college courses, for what we need and what we must have is significant knowledge." The one thing that may interfere with this increasing appreciation will be the failure on the part of the teachers of chemistry to understand that they are not being asked to make technical chemists of the students in the basic introductory course but to provide a piece of genuine scientific training, however limited, that shall lead students to understand, to trust and to appreciate the scientific habit of mind as one of the great determining factors of our civilization, and that shall put them in possession of those fundamental principles of science, serviceable whatever be their walk in life.

There has been much discussion as to whether chemistry viewed in this way as a constituent of the course in liberal arts should not have a different treatment from the course arranged for our future chemists. We have, at least, a name for such a course; but in the main, the discussions have had little influence on the character of the course.

Two methods of procedure are open to us. (1) We may separate our students into two classes, according to whether or not they expect to make chemistry their life work, and give to each class courses differing fundamentally in character; or (2) we may so shape our introductory course that it will serve the aims of education and be of value to all students alike. The first of these methods is open to the very serious objection that the course offered to the general student is likely to resolve itself into a collection of facts pertaining to chemistry, interesting undoubtedly, but serving neither the aims of education nor those of science—enjoyable bedtime reading but out of place in serious college work. Equally true, the technical course might miss many of the suggested and cultural values. It would seem entirely possible to frame a course that would be of value to all alike, providing a foundation knowledge of the science of chemistry but stressing acquaintance with fundamental laws and principles; also habits of clear thinking and inde-

pendent judgment such as contribute to constructive ability and ultimately to good living as well. Many a liberal arts student not supposing himself interested in science through such a course has had awakened the profound intellectual passion of his life.

With the belief that the basic introductory course in chemistry should be of such a character as to make it serve all students alike, the future chemist as well as the non-chemist, I propose to select one or two of the fundamental ideas concerning education that seem to me especially applicable to such a course. In doing this I shall quote directly or indirectly from such authorities as Dewey, Whitehead and Barry, for, as expressed by a recent writer in the *Atlantic Monthly,* one can not write intelligently concerning education to-day without finding oneself sooner or later cribbing from one or another of these leaders of educational thought. Moreover, I am only too well aware how inadequate the necessary condensation will seem to scholars in this field.

In brief, we are passing from the static, receptive idea of education to the dynamic idea; from the view that education consists in the mere accumulation of knowledge as an end in itself to the view that knowledge is to be sought in order that it may be used to invent, to create, to control; from an idealization of the past to an immediate concern with the present, based upon the power of scientific control. The past is our storehouse of experience and the foundation under our feet, and is of value just in so far as it is of service in guiding us into larger knowledge and into those uses and applications that contribute to right living. "Education is the art of utilization of knowledge," says Whitehead. "The only use of knowledge of the past is to equip us for the present. . . . We must beware of inert ideas, that is to say, ideas that are received into the mind without being utilized, or tested, or thrown into fresh combination." Education, then, is intimately connected with right living, with the ability to understand and relate ourselves to the civilization in which we live.

In a process of education as so conceived, we are using, and developing by using, the scientific method or habit of thought. Indeed, it is this development of the scientific method or habit of thought which is the scientist's fundamental contribution to the educative process. "From the humanistic as well as from the purely intellectual point of view, the general acquisition of scientific knowledge is of far less consequence than the inculcation of the scientific habit of thought" (Barry).

What then should be the character of our introductory course in chemistry, to the end that it will be in harmony with these modern views concerning education, and with the function of the contribution to be made by scientific training?

(1) In the first place, the subject must be chemistry, sound chemistry, fundamental chemistry; not a mere collection of interesting facts illustrated by striking experiments in which the fireworks entirely blind the students to the principles involved. Not facts in chemistry, although these are important, but ability to think in the domain of chemistry must be the chief end. Chemistry lends itself so admirably to a display of that which partakes of the miraculous that it is difficult at times for the teacher to keep from lapsing into the rôle of the prestidigitator. There is much to be said for the insistence of the late Johannes Thiele that all apparatus used in illustrating his lectures should be of the simplest possible type, most of it home-made, so that the principle to be illustrated rather than the apparatus used should engage the attention of the student.

I may be wrong, but I can not help believing that at the present time we are overstressing the popular side of chemistry to the detraction of the science itself. Popular chemistry has its place, a very important place, and we owe a great debt of gratitude to men like Harrison Howe and to our late lamented Edwin Slosson, who wrote accurately and interestingly concerning the affairs of chemistry in a way that the average person, wayfarer though he might be, could understand. We are greatly indebted also to the Chemical Foundation, and especially to Mr. and Mrs. Francis P. Garvan, for their generous aid in arousing a wide-spread interest in chemistry. But when popular chemistry finds its way into our high schools, and it is doing so, and even I fear into some of our colleges, not as an addition to but as a substitute for the side of chemistry that must prevail if our science is to serve either the aims of education or the development of the science itself, there is cause for serious thought. There is a great demand to-day, especially in our high schools, for the so-called practical chemistry, a demand that is reflected in the advertisements of our text-books in chemistry; and some seem to forget that all so-called practical chemistry to be of any value must be based upon fundamental theoretical principles. We must remember that the mere storing of one's mind with facts, however interesting they may be, is not education; neither is it science. All modern philosophies of education cry out against it. Henry Adams says somewhere, "I have never loved or taught facts, if I could help it, having that antipathy to fact which only idiots and philosophers attain," and one of his students has stated that "mere facts bored him. Adams-like he was unhappy unless he could get at laws, principles." "A merely well-informed man,"

says Whitehead, "is the most useless bore on God's earth." I suspect that it was the same idea that led the late Samuel Crothers to write that delightful essay on the "Honorable Points of Ignorance." We may well ask ourselves whether in our introductory course we are not overstressing the merely interesting and the entertaining, giving too much time to petty details rather than to fundamental principles and laws. I sometimes fear we are, and I have often wondered whether this tendency carried on through succeeding courses may not have something to do with the fact that, notwithstanding the almost lavish expenditure of money for training in chemistry in our country—far beyond that of any other nation—only one Nobel prize in chemistry has found its way to our shore.

(2) If it be true that one of the chief aims of education is the "inculcation of the scientific habit of thought," then it goes without saying that the central aim of our course in chemistry, whether in the high school or in the college, must be the development of the scientific habit of thought in the minds of the students. We talk much about the importance of this training, but I wonder how many of us keep our teaching polarized by this idea. Bertrand Russell has said in effect that while the scientist has good ideas he is slow to practice what he preaches.

(3) The end of trained thinking is scientific control. The teacher will lose a great opportunity if he fails to lead his students to see that this method of study is applicable not alone to the solution of problems that lie within the domain of chemistry, or science in general, but also to many of those problems that affect our well-being as a nation; to the problems of Muscle Shoals and to the framing of an equitable tariff law as well as to the unraveling of the vagaries of vitamin D; to the problems connected with efficient management of our cities as well as to the determination of isotopes; to the problems confronting the agricultural interests of our country as well as to the action of chlorophyl in photosynthesis. The scientific method must be the dependence in the solution of all such problems, and when this method is cast aside, either through the urgency of immediate action or because of special interests, sooner or later the penalty will be exacted. It is a pitiable spectacle to-day that the judgment of more than 1,000 of our leading economists in regard to a subject upon which they should be preeminently qualified to speak could be disregarded by that honorable body, the Senate of the United States. It shows either a woeful ignorance on the part of our economists or an entire absence of sound judgment on the part of the Senate—you may take your choice. Our Congress would hardly pass laws affecting the well-being of the human body against the protest of 1,000 of our leading physicians; but when it comes to the consideration of ailments affecting not the human body but the body politic, even the wayfarer regards himself as capable of writing the prescription.

What we need to do is to develop in our people the *scientific mind* as opposed to the *popular mind,* and the right beginning of this must be made in all the science courses of our colleges and even in our high schools. Wolfe in his book "Conservatism, Radicalism and Scientific Method" discusses the characteristics of these two kinds of minds, and I quote briefly, although not always literally, from him:

> The scientific mind is objective, impersonal, and desire is subordinated to reason; the popular mind is subjective, personal, with reason subordinated to desire. The scientific mind is observant, significantly informed, and curiosity is impersonal and disciplined; the popular mind is unobservant, ignorant, and curiosity is personal or lacking. The scientific mind is objectively skeptical, critical, tolerant, and can suspend judgment; the popular mind is credulous, uncritical, intolerant, and jumps at conclusions. The scientific mind is constructively imaginative, fearless in facing facts and courageous in defending its scientific convictions; the popular mind is fanciful, fearful of disagreeable facts and lacking in the courage of its convictions, unless motivated by special interest or backed by authority. The scientific mind has faith in law; the popular mind has faith in whim.

This development of the scientific mind in our people is a fundamental factor in promoting the welfare of our country for, as stated by Luckiesh:

> The benefit of scientific knowledge should not and will not end with its utilization in material things. Only genius can extend the border of scientific knowledge, but the humblest man can be taught its spirit. Doubtless, human beings will always have their frailties, but as the scientific spirit infiltrates more and more throughout business and industry, and thence throughout civilization, it should develop honesty and tolerance, and make better human beings.

How else than through the discipline of some one of the sciences shall our young men and women acquire this scientific habit of mind? Is it not an obligation resting upon the teacher that he keep the development of the scientific mind just as clearly in view as the content of the science he teaches? In all this the chemist must do his part.

(4) In the next place, we should not lose the opportunity afforded by our course in chemistry to teach regard for natural law.

Dr. W. W. Campbell, the distinguished astronomer, makes the following statement in reference to natural law:

> If I were asked to name and describe the most wonderful fact known to man, my reply would be: So far

as our observations and experiences go, every particle of matter in the physical universe is endowed with the property and necessity of obeying the fundamental laws of nature. Our universe of stars, our own star and our earth in all its parts have been developed throughout long ages, to their present state, under the guidance and compulsion of perfectly definite and apparently simple laws. We have no reason to suppose that these laws are ever set aside or varied in the slightest degree.

Many of these laws so govern the every-day experiences of our lives that even the most ignorant regard them. If one jumps off the housetop, one knows the penalty that will be exacted for ignoring the law of gravity. There are many other laws, however, not so obvious, which if ignored will exact a penalty affecting not only the individual but groups of individuals, and even the nation as a whole. I recall that in the chemical lecture room in which I sat as a student there was printed in large letters on the wall above the blackboard the sentence, "Nature makes no leaps." There it was day after day impressing a great fundamental truth upon the minds of the students. Perhaps this statement has not the dignity of a natural law, but it does express in a general way one of the habits of nature. The earth as it exists today did not leap into its present state. According to Sir James Jeans, 2,000,000,000 years of gradual development were required. Neither has man reached his present state overnight; it has, according to the same authority, taken some 300,000 years of slow development.

And natural law does not obtain only within the material side of the universe. The great principle of evolution is in the popular mind confined to man's derivation from a lower type; there is little understanding of the fact that the principle of evolution is of so wide an application that we have come to think of the growth of institutions and moral ideas and capacities for action as an evolutionary process. To ignore this law of slow development will as surely bring its penalty as to ignore the law of gravity. If "nature makes no leaps," then time is always a factor in development. Many of our troubles, individual, local and national, have been due to the fact that we are in too great a hurry to achieve results. We desire to improve present conditions by making a great leap. This tendency to become impatient and to get in a hurry has been the cause of more than one of our great wars, as well as of untold lesser troubles. The scientist has great respect for time, knowing that no matter how beneficial the final result may be or how strenuously we may exert ourselves to bring about the desired end, time is an essential factor in effecting the final solution.

We have only to look about us for illustrations of the trouble that results from refusing to regard this method of nature. For many years there was a slow but gradual progress made in overcoming the evils of intemperance. Through education and local option this progress continued slowly but surely. Then we got in a hurry, and almost overnight, under stress of emotion and by vote of the people we made a leap from a position in which a large percentage of our people could legally obtain liquors as a beverage to one in which no one could legally do so. By vote we substituted compulsion for education and continued development of ideas and good habits. And many seemed to be surprised at the results. Now, having ignored this fundamental habit of nature, we find ourselves in a pretty fix. Whether to go on in the hope that, somehow, in due time natural processes will catch up with our attempt and come to our rescue, or whether to return to a former position and to reach the desired end gradually but surely, is one of the most perplexing problems before the nation. The scientist does not expect the miraculous. His interest is centered not so much in bringing about a temporary improvement as in accomplishing a permanent result; and he is willing to wait the necessary time.

Recently we have been witnessing an effort on the part of our federal government to assist the agricultural interests of our country. It is very doubtful, to say the least, whether the temporary withdrawal of large supplies of grain in an effort to maintain the price is in accord with well-known principles of economics. Indeed, it would seem that such a procedure, even if temporarily successful, would continue to call forth increased production—a situation which every one should realize must be avoided if the goal of price maintenance is to be permanently attained. Some of our legislative bodies have a committee whose duty it is to see that every proposed bill is in accord with the constitutional law. It might be equally well to have a committee of competent persons to determine if the proposed bill is in accord with natural laws.

If our nation is to prosper and civilization to advance, we must take into account these fundamental laws and work patiently and intelligently in the light of them. Some of us are evidently too old to learn this or too egotistical to believe it; the young men and women in our colleges are neither. The importance of regard for natural laws should be impressed upon them in no uncertain way in the hope that future generations may be wiser than we. Again, who are better qualified to do this than our teachers of sciences, and upon whom does the obligation rest more heavily?

(5) Another fundamental fact that our course in chemistry should stress is the oneness of all science. How often the teacher of chemistry is informed by the student that he does not care for physics so he is

going to study chemistry, or that chemistry does not interest him and so he is going to study physiology, or even that he does not care for organic chemistry and so he is going to confine his studies to inorganic chemistry. We are partly to blame for this state of affairs since in the development of science we enclosed each branch of science with barriers that were well-nigh insurmountable by either student or teacher. Happily these barriers have been torn down, although not all of them in their entirety.

Furthermore, the existence of departments in our colleges and universities often misleads the student, and the present tendency to unite certain existing departments into a single one rather than to multiply them is a hopeful sign and will lead to greater efficiency. To-day no one can draw a definite line between the domain of chemistry and that of physics. Courses that are given in one university in the department of chemistry are sometimes, with perfect propriety, given in the department of physics in other universities. We are beginning to wonder if these two departments could not be united into a single department, greatly to the advantage of both student and teacher and the advancement of research.

While the barriers that formerly separated the different divisions of science have largely disappeared, disclosing a most fruitful field of study and investigation, at least traces of them still exist within each division. In our department of chemistry we rarely give courses in chemistry, but in organic chemistry or analytical chemistry or some other branch of the subject. Moreover, each division is apt to have its own special guardian, who sometimes posts his territory with "keep off" signs. Instances are by no means unknown in which the teacher whose investigations led him from his own special branch into another, as is certain to be the case, was made to feel that he was trespassing in forbidden fields. Dr. Langmuir stated last year before the division of chemical education that the course in mathematics from which he derived the greatest good was not a course in trigonometry or analytical geometry or calculus, but simply a course in mathematics in which the teacher made his selections at will from whatever branch of the subject lent itself to an understanding of the fundamental principles of mathematics as a unit. I have often thought that an admirable course in chemistry would be one in which the science was considered as a unit, and not broken up into divisions. Such a course would impress upon the minds of the students the unity of the different divisions into which, for the sake of study, we divide the domain of chemistry. Even the graduate student to-day finds it difficult to conceive chemistry as a whole. When called upon to take an examination in the field of chemistry he is likely to insist upon knowing not only the branch of the subject but also the particular course in which the examination will be given.

(6) Many of the topics that lie within the domain of chemistry are not only of fundamental importance to an understanding of the science itself but illustrate in an admirable way the development of the scientific method of study or some other important principle. Such a topic as the constitution of matter illustrates what I have in mind. Not only is this topic of primary importance in itself, a foundation stone upon which the superstructure of science is built, but the wise teacher will not fail in the discussion of the subject to use it also as an illustration of the scientific method of attacking a problem. He will point out that here we have theory in the process of making. Within a short space of time our ideas concerning the make-up of the atom have undergone radical changes, and we fully realize that the end is not yet. There is a tendency on the part of some persons to lose faith in scientists because of their changing views. But to cling to ideas not in accord with our present tested knowledge is as deplorable as the willingness to change our minds with every new whim or idea, to be blown about with every new suggestion made. Even our greatest scientists are sometimes guilty of this inertia of mind toward accepting new knowledge. The spectacle of the great Priestley, clinging to and defending the phlogiston theory, in the light of the experiments of Lavoisier and others, always seemed to me pitiable in the extreme.

May I give another illustration? Not long ago I chanced to meet an old student of mine, now grown to manhood and distinguished in many ways, especially in the domain of literature. I had an irresistible impulse to ask him whether he had derived anything of value from his course in chemistry, fully realizing that the question might prove an embarrassing one to both teacher and pupil. But it did not prove so to either, for to my great surprise he stated that if he had to select the one idea that he had gained from his college course that had been of greatest service to him in framing his philosophy of life it would be the one derived from a discussion of the periodic law. He had been much confused by what seemed to him an entire absence of order in the universe; he had read that "all this scene of man" is "a mighty maze but not without a plan"; yet he could find no convincing evidence of this plan; and he recognized for the first time in his study of the periodic law unmistakable evidence of order in the universe, for in no other kind of universe could one predict not only the existence of unknown elements, but the properties of these unknown elements as well.

This same question is still in the minds of many

students. Modern discussions concerning the universe seem to them to add uncertainties, notwithstanding the judgment of such an authority as J. A. Thomson, when he writes, "Gone is the old sense of bewildering confusion. Every day discloses some new orderliness in the Universe." But the thoughtful student will realize that a helter-skelter world is not a world in which one can predict with a great degree of certainty the existence of either unknown elements or unknown stars. And if all is not yet clear he will realize, in regard to our knowledge:

'Tis a half-time, yet Time will make it whole.

(7) If history is of value in bringing to us the experience of the past in order that it may be a guide to us in the present, then it would seem that the history of our science may well play an important part in our general course. Our students must understand that chemistry did not reach its present state of development in some miraculous way but as the result of centuries of research carried on by alchemists, by "natural philosophers" and experimenters, often at heroic cost; that chemistry is a tremendously growing, developing science right now to which the student may be the one to make a future contribution as far reaching in value as those made by the great chemists of the past and of the present.

The history of chemistry can also be made to illustrate in an admirable way the development of the scientific method of study. In the old days many facts and phenomena were attributed to the forces of nature, to the gods or the devils, rewarding or punishing men, as the case might be. But the scientific method was born. Men began to experiment, to reason, to frame hypotheses, to test them to see if they would not serve to explain the facts. If they did not, the hypotheses were modified or new ones framed, until at last a working theory was evolved. As time went on new facts brought to light may have necessitated further change in theory or caused the substitution of an entirely new one in its place. The phlogiston theory served its day but gave way to the onward march.

Moreover, the study of the history of chemistry can hardly fail to have an influence upon the student's attitude towards life, call it his philosophy of life if you choose. He is no longer in fear of the displeasure of evil forces or imaginary spirits whose anger must be constantly appeased. If he is ever to be struck by lightning, as some one has said, in effect, he knows that it will be due not to the anger of the god of thunder but because under the existing conditions his body offers the least resistance to the passage of the electric discharge. Moreover, he knows how to avoid these conditions and the lightning loses its terror. He realizes that he is living in a world governed not by chance or whim but by natural laws; that he can count absolutely upon the action of these laws; he knows that they will never be set aside either to his advantage or to his disadvantage. He feels secure, then, in ordering his life in accord with reason and not subject to the wild chance of unknown forces.

Perhaps, from the statements I have made, some may think that I would rob the fundamental course largely of its chemical content; that I would present the play without the actor who really makes the play. To all such let me recall the statement already made that the course must deal with chemistry, fundamental chemistry. What I am pleading for is that the course should be in accord with our modern ideas of education; that it should stress fundamental laws and principles rather than mere isolated facts, and that whenever any of these laws have an application beyond the domain of chemistry there should be no hesitation in suggesting this application. It may be that a course so constituted would leave less time for the discussion of purely chemical facts; but this does not concern me. An examination of the various courses in chemistry in at least some of our colleges leads one to believe that we are expecting the student to learn all there is to know about chemistry while in college, rather than to build a foundation for future development. My principal theme is that our teachers of chemistry have a great opportunity not only to train the future chemists of our country but also to train our young men and women in the ways of right living and sound scientific thinking.

And finally the teacher of chemistry, in his enthusiasm for the value of science, must not forget that after all science is not everything. For the teacher who has awakened great enthusiasm in his students, who has developed in them the scientific habit of thought and a knowledge of the place of chemistry in the whole field of science, has not done quite his best for them unless he has reminded them by frequent suggestions and by his own attitude that science is but one way of thinking—not the only way; indeed, in the last analysis, it is "a method plus its body of significant knowledge." The other great departments of university work should be a constant reminder of this; the science student too often feels separated from them, and sometimes he even feels he has outgrown them. He must be made to realize that science does not give us the values of life, it does not harness its knowledge to ideal interests. Professor Dewey tells us that "the standing problem of modern philosophy is the relation of science to the things we prize and love, which have authority in the direction of conduct." Indeed, it may be that a great change is going on in our sense of values and in the basis of their authority, so that our aims may be confused, and we

may have a long way to go in our enlargement from individual to social ideals. But in furnishing knowledge, sought out for the very testing of values, in a creative attitude and a method of building toward the "good life," the scientific worker has a great contribution to make. His may be the optimism, when faith is failing in some other domain of the spirit; a humble attitude toward his own part, a generous understanding of the larger whole in which his work finds its significance.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE FOURTH CLEVELAND MEETING

Preparations for the fourth Cleveland meeting of the American Association and associated societies are well advanced. The meeting is to open on the evening of Monday, December 29, and it will continue throughout the week. This promises to be one of our larger and more comprehensive meetings. More than thirty independent scientific organizations are planning to hold meetings in connection with the association this year and all sections of the association will be represented. The American Statistical Association, the American Sociological Society, the American Economic Association, the American Political Science Association, the Stable Money Association, the American Association for Labor Legislation, the American Association of Teachers of Marketing and Advertising, the American Association of University Instructors in Accounting and the Farm Economics Association are also making arrangements to meet in Cleveland in convocation week. Their sessions are to be held in the downtown hotels, while the association sections and the other societies will hold most of their sessions in rooms of the Case School of Applied Science and Western Reserve University, which are adjacent.

According to the rules, the council of the association will meet Monday afternoon for its first Cleveland session and other council sessions will be held at 9 o'clock on the following days. Council members are asked to attend. The executive committee will hold a session on Monday morning. Business to come before the council at Cleveland is to be referred to the executive committee first, and memoranda concerning such business should be in the Washington office by December 20. Communications that arrive late, especially those coming to the permanent secretary after the opening of the meeting, may fail to receive consideration, for the week of the meeting is a very busy one for all officers of the association.

Reduced railway rates for this meeting have been granted by the railway associations, on the certificate plan, as in recent years. Any one wishing to go to Cleveland for the meeting should purchase a one-way ticket and secure a certificate for the meeting of the American Association for the Advancement of Science. Names of societies do not need to be mentioned. Upon arrival at the meeting the certificate is to be handed in at the registration office. After being endorsed and validated it will be returned to its owner, who may then purchase a return ticket at one half the regular fare. This arrangement applies for practically all places in the United States and Canada.

The Hotel Statler is to be general headquarters for the American Association. Hotel headquarters for the sections and societies have been designated as follows:

Hotel Statler: Section A (Mathematics), American Mathematical Society, Mathematical Association of America, Section B (Physics), American Physical Society, American Meteorological Society, Section D (Astronomy), Metric Association, American Association of University Professors.

Hotel Hollenden: Section F (Zoological Sciences), American Society of Zoologists, Entomological Society of America, American Association of Economic Entomologists, American Society of Parasitologists, Wilson Ornithological Club, Section G (Botanical Sciences), Botanical Society of America, American Phytopathological Society, American Society of Plant Physiologists, American Society of Naturalists, Ecological Society of America, American Microscopical Society, Phi Sigma Biological Research Society, Section N (Medical Sciences), American Society of Tropical Medicine, Section O (Agriculture), American Society of Agronomy, American Society for Horticultural Science, Potato Association of America, Association of Official Seed Analysts, American Nature Study Society.

Hotel Winton: Section H (Anthropology), American Anthropological Association, American Folk-Lore Society, Section I (Psychology), Section L (Historical and Philological Sciences), History of Science Society, Section Q (Education), Section C (Chemistry), Section E (Geology), Section M (Engineering).

Hotel Cleveland: Section K (Social and Economic Sciences).

The hotel headquarters for the social-science groups are as follows:

Hotel Statler: American Statistical Association, American Political Science Association.

Hotel Hollenden: American Sociological Society.

Hotel Winton: Stable Money Association.

Hotel Cleveland: American Economic Association, American Association for Labor Legislation, American Association of Teachers of Marketing and Advertising, American Association of University Instructors in Accounting, Farm Economics Association.

These hotels are within walking distance of one another and about four miles from the university grounds, with excellent street-car and bus service.

Those who plan to attend the Cleveland meeting should engage rooms in advance. The most desirable rooms are apt to be engaged first and delay may result in some disappointment. Letters requesting the engagement of rooms should be addressed to the hotels. Whether the room desired is to be occupied by one or by two persons should be specified, also the price which the applicant wishes to pay and the date on which the room is to be occupied. If the sort of room requested is not available for the given date the hotel management will refer the request to the Cleveland Convention Board, which will tentatively assign a suitable room in another hotel, informing the applicant by letter. If the applicant does not wish to accept the assignment thus given he should inform the Convention Board, which will do its best to comply with his wishes. All the rooms in the hotels named above are equipped with baths and the daily charge for a single room is $3.00 and up. For double rooms the daily charges are: Hotel Cleveland, $5.00 and up; Hotel Hollenden, $6.00 and up; Hotel Statler, $4.50 and up; Hotel Winton, $4.50 and up.

An extensive list of Cleveland hotels has been prepared by the permanent secretary's office, with the assistance of the Cleveland Chamber of Commerce, and a copy of this may be had on request addressed to the American Association for the Advancement of Science, Smithsonian Institution Building, Washington, D. C. The list shows the hotel locations and their daily prices for single and double rooms, with and without bath. Those who desire inexpensive rooms should write for a copy of the list. Prices for single rooms generally range from $2.00 or $2.50 upward, for double rooms from $3.00 upward.

At the opening session on Monday evening, December 29, Dr. Robert A. Millikan will give the retiring presidential address for this annual meeting. All workers in science and friends of science will be interested. The Sigma Xi Lecture, on Tuesday evening, December 30, will be given by Dr. C. E. K. Mees. The Gibbs lecture (under the auspices of the American Mathematical Society and the American Association) will be given on Tuesday afternoon by Dr. Edwin B. Wilson. There will be general lectures every afternoon and every evening, as at recent annual meetings. The science exhibition will be specially interesting this year, with a number of striking research exhibits. The General Program will be available at Cleveland Monday morning. Members of the association who are unable to attend the meeting may have a copy promptly mailed to them without charge if their requests are in the permanent secretary's office in Washington by December 20.

Further notes on arrangements for the Cleveland meeting will appear in SCIENCE from time to time and the "Preliminary Announcement" will be published in the issue for November 28.

BURTON E. LIVINGSTON,
Permanent Secretary

OBITUARY

MEMORIALS

TRIBUTE TO THE LATE HARVEY W. WILEY

THE Association of Official Agricultural Chemists, at its forty-sixth annual convention, held in Washington, D. C., on October 20, 21 and 22, set aside, according to the *Official Record* of the U. S. Department of Agriculture, part of the second day's session to honor the memory of Dr. H. W. Wiley, former chief of the Bureau of Chemistry and one of the founders of the association, as well as its second president and, from 1912 to 1930, its honorary president. Until 1929, when illness confined him to his home, Dr. Wiley attended every meeting of the association and the talk he gave was usually the outstanding feature of the program.

Dr. W. W. Skinner, assistant chief of the Chemical and Technological Research, Bureau of Chemistry and Soils; Dr. W. D. Bigelow, one-time assistant chief of the Bureau of Chemistry and now the chief chemist for the National Canners' Association, and Mrs. M. T. Read, editor, and Mr. F. B. Linton, assistant to the chief, Food and Drug Administration, all of whom were associated with Dr. Wiley through his fight for the passage of the food and drugs act, recalled vividly the qualities of the teacher, the public servant, the boss, and the man that made their chief an outstanding figure.

Mr. W. G. Campbell, who, as director of regulatory work of the department and chief of the Food and Drug Administration, is carrying on the control of the country's food and drug supply begun by Dr. Wiley, paid tribute to his former chief as "the leader." Dr. C. A. Browne, assistant chief of the Bureau of Chemistry and Soils, stressed Dr. Wiley's reputation as a

chemist throughout Europe, as well as in the United States. Mr. H. A. Huston, a member of one of the first classes conducted by Dr. Wiley at Purdue University, spoke of "the organizer." Mr. A. S. Mitchell, secretary of the food standards committee, gave tribute to "the pioneer."

THE College of Physicians of Philadelphia held a meeting October 23 to commemorate the anniversary of the birth of Galen, called the founder of experimental physiology. Ninety-three of the ninety-eight Galen publications, the property of the college library, were on exhibition. The meeting was addressed by Drs. William H. Welch, Charles W. Burr, Burton Chance and Giuseppe Franchini, of Bologna, Italy.

RECENT DEATHS

OLIVER PERRY HAY, retired associate of the Carnegie Institution of Washington, known for his researches in Pleistocene paleontology and as author of the "Catalog and Bibliography of the Fossil Vertebrates of North America," died on November 2 in his eighty-fourth year.

EDWARD WYLLYS HYDE, for twenty-five years professor of mathematics at the University of Cincinnati and formerly treasurer and actuary of the Columbia Life Insurance Company, has died at the age of eighty-seven years.

HENRY EMERSON TREFETHEN, associate professor of astronomy at Colby College, died suddenly on November 3. He was seventy-five years old.

DR. CHRISTIAN EIJKMAN, professor of hygiene and medicine at the University of Utrecht, to whom the Nobel Prize in medicine was awarded for his work on beriberi, died on November 5, at the age of seventy-two years.

DR. WALDEMAR MORDECAI WOLFF HAFFKINE, known for his work on Asiatic cholera, died at Lausanne, Switzerland, on October 27, at the age of seventy years. He discovered the principle and method of inoculation with attenuated virus against cholera. The Haffkine method of inoculation has been generally adopted throughout India and the government plague research laboratory founded by Dr. Haffkine has issued many thousands of doses to various tropical countries.

SCIENTIFIC EVENTS

THE FRENCH PUBLIC HEALTH SERVICE

RECENT mortality statistics for France are reported in the *Journal* of the American Medical Association to have caused deep regret. The birth rate in France had risen, whereas it was declining elsewhere in Europe. The mortality had begun to drop down somewhat and the whole country was pleased over the fact, when suddenly it began to rise again. From 675,110 in 1928, it rose to 741,104 in 1929, or 70,000 deaths more, in which the deaths of the new-born played but an insignificant part. The increase concerns chiefly the adults. The correspondent writes: "The condition can be due only to the inadequate nature of the public health service, in spite of all the exertions made in this direction. It is becoming more and more clear that the law of 1902 in regard to public hygiene, a law recognized by all as inadequate and which there is constant talk of amending, although nothing is done, is the true cause of this sad state of affairs. The fundamental weakness of the present law, to which frequent attention has been called, is that it leaves to the mayors of the communes the task of applying the hygienic measures that are needed. Unfortunately, however, the authority and influence of the mayor in the majority of the rural communes are entirely inadequate to the needs of the situation. Furthermore, the mayor, being dependent on the voters for his reelection, is not inclined to punish vigorously infractions of the health regulations. Then, again, though the mayor may be honest in his endeavors, many of the communes are too poor to carry out the hygienic measures that are needed; for example, for the installation of a modern water system; or for the care of the indigent or of the mentally ill who have to be transported to the hospitals of the neighboring city. It is in such situations as this that government aid appears to be indicated. But it would require the expenditure of immense sums throughout France if the government were to attempt to do everything for the poorer communes that considerations of health might dictate. However, considerable sums have been appropriated by the government during the past two years to aid the communes, either in the form of subventions or in the form of loans at a low rate of interest, more particularly for the installation of water systems. Hygienic undertakings, which are the next thing in order after the introduction of a water system, may be aided to the extent of 800,000 francs ($32,000) in place of 400,000 francs ($16,000), as formerly. From the foregoing, it would appear unfortunate that improvement in the public health service, on which the lowering of the mortality depends, is a question of finance."

THE BRITISH NATIONAL PHYSICAL LABORATORY

THE report of the National Physical Laboratory for 1929, summarized by *The British Medical Journal*, contains a detailed account of the many investiga-

tions on which that institution is continually engaged. These cover the fields of general physics, radiology, acoustics, optics, electrical standards and measurements, wireless, metrology, aerodynamics and metallurgy. During last year the physics department of the laboratory was engaged on the measurement of several grams of radium purchased by the National Radium Trust for distribution by the Radium Commission to the centers authorized to receive it. This work has involved the testing of the platinum containers for leakage as well as the determination of the radium content. An instrument has been designed at the laboratory for the rapid visual identification, with the minimum of handling, of the large numbers of radium needles, tubes and applicators which come to Teddington for testing. There was noted during the year a marked increase in the number of tests on feebly active preparations, such as radio-active waters, ores, luminous compounds and the like. In X-ray measurement the workers in the department have been establishing the international unit of radiation, the "Roentgen," or "*r*" unit, which was adopted at the Stockholm conference in 1928, and measuring the pastille dose in this unit. Investigation into certain problems relating to the energetics of X-rays has been started, and the construction of a constant voltage generator for this purpose is well advanced. Among the problems which it is proposed to examine is the variation of X-ray output with tube voltage, anticathode material, and the angle which the X-rays make with the target surface and with the exciting cathode rays. The testing of protective materials and the inspection of X-ray equipment and hospital installations in accordance with the recommendations for X-ray and radium protection have been continued. Some interesting work has also been done on sound, a line of research to which little attention was paid until recent years. The production, reception and analysis of sound and speech, and their reproduction, transmission and magnification for broadcasting, telephony and similar purposes, have brought many problems to the laboratory. Experiments are in progress for the Aeronautical Research Committee with the object of reducing the noise of the flight of aeroplanes. High speed in an aeroplane contributes much to noisiness; an increase in 100 feet per second in speed multiplies the sound tenfold. The noise in the cabin of an aeroplane is stated to be one thousand times that in an express train. A portable noise-measuring instrument has been devised for preliminary work, and a number of measurements of air-screw noises have been made. Street noises, in particular the noise due to motor horns, are also being investigated. On the subject of glare—a parallel infliction—the laboratory is working on the effects of colored light sources, and on the problem of vision under night-driving conditions. Another useful side of the National Physical Laboratory's work is temperature research undertaken for the Food Investigation Board, including a study of distant-reading thermometer outfits. An electric resistance thermometer designed at the laboratory for cold storage work has been patented. A refrigerating railway truck, built for one of the railway companies, has been the subject of test. The truck is provided with a small methyl chloride refrigerating plant driven from the axle. A number of investigations have been made on long-distance journeys, which have shown that the plant is capable of cooling the truck and its cargo sufficiently rapidly, and also that the rate of temperature rise when the plant is not in operation is sufficiently slow. One part of the routine work of the laboratory is the testing of clinical thermometers. More than ten thousand of these were tested last year, and the demand for individual certificates showing the actual corrections at various points of the scale has increased by thirty per cent., as compared with the number issued in the pervious year.

THE WALTER RATHBONE BACON SCHOLARSHIP OF THE SMITHSONIAN INSTITUTION

UNDER the terms of the will of the late Virginia Purdy Bacon, of New York, the Smithsonian Institution some years since was bequeathed the sum of $50,000 to establish a traveling scholarship as a memorial to her husband, Walter Rathbone Bacon, for the study of the fauna of countries other than the United States. The amount available is the interest on the capital invested (about $3,000 a year), the incumbent to hold the scholarship not less than two years.

Applications for this scholarship, addressed to the secretary of the Smithsonian Institution, should be submitted not later than January 31, 1931. The application should contain a detailed plan for the proposed study, including a statement as to the faunal problems involved, the reasons why it should be undertaken, the benefits that are expected to accrue, the length of time considered necessary for the carrying out of the project, the estimated cost and the scientific and physical qualifications of the applicant to undertake the project.

The scholarship will be awarded for a term of two years. If at the expiration of the term it is desired to extend the time, the incumbent shall make application a sufficient time in advance, accompanied by a statement as to the necessity for such extension.

All collections, photographs, records and equipment become the property of the institution.

The incumbent shall not engage in work for remuneration or receive salary from other sources than the institution or its branches during the period of occupancy of the scholarship.

C. G. Abbot,
Secretary

SUMMER SCHOOL FOR ENGINEERING TEACHERS

The Society for the Promotion of Engineering Education announces that two sessions of its Summer School for Engineering Teachers will be held in 1931.

The first, on the teaching of chemical engineering, will be held at the University of Michigan from June 24 to July 14, inclusive. This session is being held in response to a suggestion by the American Institute of Chemical Engineers. Professor Alfred H. White, chairman of the department of chemical engineering of the University of Michigan, will serve as the local director.

The second, on the teaching of mathematics to engineering students, will be held at the University of Minnesota from August 24 to September 5, inclusive, in conjunction with meetings of the American Mathematical Society and the Mathematical Association of America, to be held at Minneapolis beginning September 7. This session of the school will be under the direction of Dean O. M. Leland, of the College of Engineering and Architecture, University of Minnesota.

The two sessions for 1931 will bring the total number of sessions held since the establishment of the school to eleven. This undertaking, which was begun in 1927, has now attracted 750 teachers to its sessions. The attendance has represented all parts of the United States and Canada and all teaching ranks. From small beginnings, with attendances of 40, the sessions have grown in numbers, 190 teachers attending those of 1930.

The programs are devoted primarily to principles and methods of teaching the principal subjects of engineering curricula. The contents of courses, including classroom procedure, examinations and tests, departmental organization and other topics relating directly to the major purposes of the school, are presented through lectures, informal discussions and in seminar periods. Incidental attention is also given to the history of the subject, coordination with other subjects of the curriculum, advanced phases of the subject, relationship with engineering practice and other topics.

Members of the school, including the staff, live together for the duration of the sessions in a dormitory of the institution acting as host. Recreational features are provided as a part of each session. It is expected that from 50 to 100 teachers will attend each of the sessions of 1931 as "students." The teaching staffs, as in the past, will be recruited from among the leading teachers, engineers and scientific men of the country. Professor H. P. Hammond, of the Polytechnic Institute of Brooklyn, is the general director of the school.

SCIENTIFIC NOTES AND NEWS

The University of Paris presented honorary doctorates on November 8 to Dr. John Dewey, professor of philosophy at Columbia University, and to Professor P. Zeeman, professor of physics at the University of Amsterdam.

On his return to Stockholm from China, in the spring of 1931, where he has been making explorations in Tibet and Mongolia, Dr. Sven Hedin will be presented with the first "Hedin Medal" by the Swedish Anthropological and Geographical Society.

At a dinner on October 31 on the occasion of the presentation to Mr. Daniel C. Jackling by the American Institute of Mining and Metallurgical Engineers of the William Lawrence Saunders Gold Medal, Mr. John Hays Hammond, the 1929 Saunders medallist, was the toastmaster. The speakers were Mr. Newcomb Carlton, president of the Western Union Telegraph Company; Mr. Lafayette Hanchett, president of the Utah Light and Power Company and Mr. W. S. Boyd, assistant managing director of the Nevada Consolidated Copper Company.

The Reverend T. E. R. Phillips, rector of Headley, Surrey, has been awarded the Goodacre medal and gift of the British Astronomical Association, in recognition of his work generally for the association and particularly of his observations and researches on Jupiter. Mr. Phillips already holds the Jackson-Gwilt medal and gift of the Royal Astronomical Society, of which body he has been president and secretary.

Nature reports that the Horace Brown Medal of the Institute of Brewing is awarded by the council for "eminent services on the scientific or technical side of the fermentation industries." The first award was made to Professor H. E. Armstrong in 1926, and the next recipient of the medal is to be Dr. E. S. Beaven, known for his work on barley. The presentation will be made by the president, Mr. Percy Gates, in the lecture theater of the Institution of Electrical Engineers, on November 21, when Dr. Beaven will deliver the memorial lecture on "The Culture of Barley for Brewing."

At the centenary celebration of the Royal Geographical Society, Mr. E. John Voüte, Amsterdam, one of the foreign delegates, presented to Sir Francis Younghusband the gold medal of the K. Nederlandsch Aardrijkskundig in recognition of his work in geographical research and his services to the Royal Geographical Society, of which he was honorary secretary and president. Diplomas conferring honorary membership of the Dutch society were presented to Sir Charles Close, Mr. Douglas W. Freshfield and Mr. A. R. Hinks, secretary of the Royal Geographical Society. Commander Maury, a delegate of the Belgian Geographical Society, presented diplomas of honorary membership to the president and secretary.

Rear Admiral Richard E. Byrd will be presented the gold medal of the Geographical Society of Chicago on November 16 in recognition of his expeditions to the North and South Poles. Admiral Byrd will be the ninth person to receive the medal since its inception in 1913.

Dr. Hugo Eckener has been elected president of the Aero Arctic Society, Berlin, as successor to the late Fridtjof Nansen.

Dr. Robert Tait McKenzie will retire as professor of physical education and physical therapeutics at the University of Pennsylvania on the completion of a survey of student health, but will retain an affiliation with the university. He will devote most of his time to sculpture. He was sculptor of the Franklin statue at the University of Pennsylvania, the Scottish-American War Memorial at Edinburgh and the War Memorial in the Parliament Building at Ottawa.

Dr. Lynds Jones, professor of animal ecology and curator of the zoological museum of Oberlin College, has retired from active service. He has been asked to give his full time during the current year to recataloguing and rearranging the museum.

After forty-seven years' service to Vassar College, Dr. Elizabeth B. Thelberg, of the department of physiology and hygiene and resident physician of the college, has retired.

Lord D'Abernon has been elected president of the National Institute of Industrial Psychology, in succession to the late Earl of Balfour, its first president.

Under the Order in Council dated February 6, 1928, the Lord President of the Council has appointed Dr. E. J. Butler, Dr. Kenneth Lee and Dr. N. V. Sidgwick to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research. The following members of the Advisory Council have retired on completion of their terms of office: Professor V. H. Blackman, Professor F. G. Donnan and Professor F. A. Lindemann.

Dr. Ralph H. Cheney, chairman of the biology department at the College of Arts and Sciences, Long Island University, has been awarded a grant by the American Academy of Arts and Sciences for further study of the action of caffein on the neuro-muscular mechanism.

Professor R. C. Archibald, of the department of mathematics at Brown University, has been appointed a lecturer in mathematics at Harvard University for the second semester.

Dr. Willard C. Rappleye, professor of hospital administration at Yale University and director of the New Haven Hospital, has been made associate professor of medical economics at the Harvard University School of Public Health, beginning in February.

Dr. Carl H. Lenhart was recently added to the faculty of the School of Medicine of Western Reserve University, Cleveland, as professor of clinical surgery and as chief of the division of surgery of the City Hospital. Dr. Lenhart will retain his office as director of the surgical division of St. Luke's Hospital, but will give half his time to the new position at City Hospital.

Dr. Claude S. Beck, assistant professor of surgery in the School of Medicine of Western Reserve University, was given the title of "professor *pro tempore* of surgery" by Emory University at Atlanta, Georgia, where he was acting as an exchange professor from November 2 to 9, as a substitute for Dr. Daniel Elking. On November 6, Dr. Beck addressed the Fulton County Medical Society in Atlanta on "Surgery of the Pericardium."

Professor R. B. Thomson, head of the department of botany of the University of Toronto, who has been granted a year's leave of absence on account of his health, is spending the winter in the south, visiting Trinidad, Jamaica, British Guiana, etc.

Dr. A. W. Hill, the director of the Royal Botanic Gardens, Kew, has left England to make a tour in the Union of South Africa on the invitation of the Government of the Union of South Africa. Dr. Hill expects to visit the botanical and allied institutions around Capetown, Port Elizabeth, Johannesburg and Pretoria and to pay a visit to Natal. The government has deputed Dr. I. B. Pole Evans, chief of the division of botany of the Department of Agriculture, Pretoria, to arrange for the tour and to accompany Dr. Hill. On leaving South Africa on January 2, Dr. Hill will proceed to Uganda and Kenya, by arrangement with the Colonial Office and the respective gov-

ernments. He will then go to the Amani Institute, Tanganyika Territory, to attend the Conference of Directors of Agriculture to be held at Amani at the end of January. He will be attending this meeting with Mr. F. A. Stockdale, agricultural adviser to the Secretary of State for the Colonies. Dr. Hill expects to return to Kew early in March, going home from Mombasa by the East Coast.

THE twenty-fourth Hanna Lecture of Western Reserve University was delivered at the Institute of Pathology on October 31 by Professor M. Weinberg, of the Pasteur Institute, Paris. His lecture was on "The Rôle Played by the Anaerobes in the Etiology, Pathogenesis and Evolution of Infectious Diseases." Dr. Weinberg will lecture on November 19 and 20 at Iowa State College, where he will speak on the relation of anaerobic bacteria to infectious diseases and on the seral therapy of polymicrobic infections.

DR. K. S. LASHLEY, professor of psychology at the University of Chicago, will deliver the second Harvey Society Lecture at the New York Academy of Medicine, on Thursday evening, November 20. His subject will be "Mass Action and Localization of Functions in the Cerebral Cortex."

THE Science Forum of the New York Electrical Society, jointly with the Museums of the Peaceful Arts and the New York section of the American Institute of Electrical Engineers, has arranged a demonstration and a lecture entitled "Play-o-fine Crink-a-nope" (a sample of scrambled speech), by Mr. Sergius P. Grace, assistant vice-president of the Bell Telephone Laboratories, on November 19 at 8:15 P. M., at Mecca Temple, 133 West Fifty-fifth Street, New York City. Owing to the demand for seats the lecture will be repeated the following evening.

THE Fifth Pacific Science Congress will be held in Victoria and Vancouver, British Columbia, Canada, between May 23 and June 4, 1932, under the auspices of the National Research Council of Canada. Previous congresses in this series were held at Honolulu, 1920; at Sidney and Melbourne, Australia, 1923; at Tokyo, Japan, 1926, and at Batavia and Bandoeng, Java, 1929.

THE Society of American Foresters will hold its thirtieth annual meeting in Washington, D. C., from December 29 to 31. It is expected that Colonel W. B. Greeley, former chief of the Forest Service; Dr. Ray Lyman Wilbur, Secretary of the Interior, and Dr. John C. Merriam, president of the Carnegie Institution, will give their views on the public-land policy of the United States, and that foresters, including Inman F. Eldredge, forester of the Superior Pine Products Company; E. F. Jones, forest engineer of the Great Northern Paper Company, and J. E. Rothery, forest engineer of the International Paper Company, will set forth the accomplishments of private forestry enterprises.

DR. JOHN A. FERRELL, of the Rockefeller Foundation, New York, was elected president of Delta Omega, the honorary public health society, at the annual meeting held in Fort Worth, Texas, on October 29. Dr. Ferrell succeeds Dr. C. C. Young, of Lansing, Michigan. Other officers elected were Drs. James A. Tobey, New York, *vice-president*, and Professor Ira V. Hiscock, of the Yale School of Medicine, New Haven, *secretary-treasurer*. Dr. George W. McCoy, director of the National Institute of Health, Washington, D. C., was elected an honorary member of the society. Delta Omega now has 316 members, distributed in six chapters at the Johns Hopkins School of Hygiene and Public Health, the Harvard School of Public Health, the Massachusetts Institute of Technology, the University of Michigan, the Yale School of Medicine and the University of California. The honorary members of the society include President Hoover, Surgeon General H. S. Cumming, Dr. Charles V. Chapin, Dr. F. F. Russell, Sir Arthur Newsholme, Dr. W. S. Rankin and Dr. S. Josephine Baker. The society has made arrangements with the American Public Health Association for the reprinting of Dr. William Budd's classic work on typhoid fever, which first appeared in 1873.

SECTION I (Psychology) of the American Association for the Advancement of Science will hold its sessions on Friday, January 2, in Cleveland at a place to be designated later. Professor Madison Bentley, of Cornell University, the retiring vice-president of the section, will give the vice-presidential address at the afternoon session on January 2 on "Psychology's Family Relations among the Sciences." The meeting of Section I has been set on January 2 so as not to interfere with the meetings of the American Psychological Association on December 29, 30 and 31 at Iowa City. It is possible for persons who wish to attend both meetings to reach Cleveland easily in time for the meetings of Section I. All fellows and members who wish to read papers should submit titles with an estimate of the time required up to a limit of 20 minutes, to the secretary of the section not later than November 22. The preliminary announcement of the section meetings will appear in SCIENCE, and the final program will appear in the general program of the association. The headquarters of Section I will be in Hotel Winton.

AT the meeting on November 7 of the Johns Hopkins Fellowship Conference, President Joseph S. Ames announced the endowment of eight new fellowships in

the national chemical fellowship plan. The purpose of the department of chemical education, of which Dr. Neil Gordon is the head, is to obtain fellowships which will bring a student to Johns Hopkins from every state and from foreign countries. The Coca Cola Company, of Atlanta; G. A. Pfeiffer, of New York, and the Central Chemical Company of Chicago, each gave one of the new fellowships; the American Can Company, three, and the Chemical Foundation of New York, two. Thirty fellowships have now been founded. Two fellowships at large, contributed by Mr. Francis P. Garvan, who endowed the chair of chemical education under which the national fellowship plan is operating, will also soon be put into effect.

PLANS to unite the engineering profession, educational institutions and the industries in improving engineering education are announced by H. Hobart Porter, chairman of the Engineering Foundation. A Research Committee on Education, headed by Dr. Harvey N. Davis, president of Stevens Institute of Technology, will frame a program whose objective will be to meet the demands of industry and public service for professional education of high quality. Dr. Davis's associates on the committee are Professor William B. Plank, of Lafayette College; Professor Harold B. Smith, of the Worcester Polytechnic Institute; Professor Alfred H. White, of the University of Michigan; Mr. Robert E. Doherty, consulting engineer of Scotia, New York, and General R. I. Rees, of the American Telephone and Telegraph Company.

PLANS have been announced for the erection of a new building at the Massachusetts Institute of Technology, housing unusually complete physics and chemistry laboratories. Funds are available from the gift of $2,500,000 given by Mr. George Eastman in 1916. Beside the laboratories, the new structure will include a shop for the construction and maintenance of delicate instruments used in research work, a large lecture room, and a joint library and reading room for the use of students in physics and chemistry.

THE State Department of Public Welfare and the College of Medicine of the University of Illinois recently dedicated four buildings—The State Orthopedic Institute, The Institute for Juvenile Research, The Nurses Home and The Research and Educational Hospital Service Building between Lincoln and Wood Streets, Chicago, on October 29. These buildings are units of the Research and Educational Hospital operated by the University of Illinois. Mr. A. L. Bowen, superintendent of charities of the State of Illinois, presided. Addresses were given by Governor Louis L. Emmerson, Dr. Harry Woodburn Chase, president of the University of Illinois, and Rodney H. Brandon, director of the Department of Public Welfare. After the dedication the cornerstone of the Medical and Dental Laboratory Building, to be erected at a cost of $1,500,000, was laid. These laboratories are designed to accommodate two hundred students in a class. The Research and Educational Hospital has a capacity of four hundred and fifty beds.

APPLICATIONS for associate biochemist (animal body fluids) must be on file with the United States Civil Service Commission, Washington, D. C., not later than December 10. The entrance salaries range from $3,200 to $3,800 a year. This examination is to fill vacancies in the Bureau of Animal Industry, Department of Agriculture, for duty in Washington, D. C., and in the field. Competitors will not be required to report for examination at any place, but will be rated on their education, training and experience, and on a thesis or published writings.

DR. CLARENCE J. WEST sends the following correction to the article on doctorates in the sciences 1929–30: "The Registrar of the State University of Iowa informs us that an error was made in transmitting to us the number of doctorates conferred in the sciences by Iowa in 1929–30. Instead of nine, as reported in Table V (SCIENCE, 72: 357, Oct. 10, 1930), Iowa should be credited with twenty-eight. The new data make necessary the following correction in Tables III and IV: Chemistry, 317; zoology, 102; psychology, 97; physics, 91; mathematics, 75; metallurgy, 4; total, 1,074.

Nature reports that the twenty-first Annual Exhibition of Electrical, Optical, and other Physical Apparatus will be held by the Physical Society and the Optical Society from January 6 to 8, 1931, at the Imperial College of Science and Technology, South Kensington. As on previous occasions, there will be a trade section and a research and experimental section, and the section for the work of apprentices and learners, introduced at the last exhibition, is to be continued. The research and experimental section will be arranged in three groups: (*a*) exhibits illustrating the results of recent physical research; (*b*) lecture experiments in physics; (*c*) historical exhibits in physics. No charge will be made for space or catalogue entries in the research and experimental section.

THE *Journal* of the American Medical Association reports that on recommendation of the Royal Commission on Public Welfare in Ontario, Premier Ferguson has announced the creation of a department of public welfare with the Honorable W. G. Martin as minister. The commission advises that public funds finance the general hospitals, which now receive for indigent patients a grant of 60 cents daily

per patient from the province, and $1.75 daily per patient from the municipality. The total general hospital revenue last year was $10,140,782. The commission emphasized the need of a government owned psychiatric hospital and to assist institutional schools in caring for Ontario's 6,000 crippled children, 2,000 blind and 3,000 deaf and dumb persons, recommended the division of the province into ten districts, in each of which will be stationed a graduate nurse or social worker supervised by a special government officer. It was recommended that the raising of funds to effect other recommendations of the commission should be patterned after the Quebec plan, in which more than $600,000 is raised annually by a hospital tax of 5 per cent. of the cost of all meals over $1, levied in hotels and restaurants. Among the recommendations was one which advised that a special conference of medical men be convened to study cancer treatment and that the province establish a cancer hospital and purchase a supply of radium. Emphasis was laid on the need of preventive clinics, provisions for occupational training for convalescents, and aid in the rehabilitation of tuberculosis patients on discharge.

According to *Nature*, with the cooperation of the authorities of various national museums, the British Museums Association organized a short training course for curators during the week of October 6–11. The course was attended by thirty-three students from provincial museums, for the most part junior assistants, though a few seniors were glad to avail themselves of this opportunity. The gathering was welcomed in the new Conference Hall at the Science Museum by Sir Henry Lyons, when an opening address on first principles of museum work was given by Dr. F. A. Bather, and Dr. E. E. Lowe discussed some fundamental points in museum practice. Succeeding days were devoted to the Victoria and Albert Museum, with demonstrations on textiles, wood furniture, ceramics, prints and the circulation department; the Natural History Museum, with demonstrations on habitat groups, casting of whales, preparing spirit specimens, and preparation of fossils for exhibition; the National Galleries in Trafalgar Square and at Millbank, with talks on storage, cataloguing and the explanation of pictures; the laboratory of the British Museum, with a lecture on restoration of Egyptian relics.

DISCUSSION

SOME CRITICISMS OF "RACE CROSSING IN JAMAICA"

In Science, No. 1850, Castle criticizes Jennings and me for certain conclusions drawn by Steggerda and me in "Race Crossing in Jamaica" (1928) and utilized by Jennings in his book "The Biological Basis of Human Behavior." The vigor of Castle's criticism reminds me of a boyhood experience, when absorbed in watching a procession. A woman next to me let out a shriek, crying, "You are stepping on my corns." Castle has two well-developed scientific corns: one, that size factors in mammals are general factors affecting all parts of the skeleton simultaneously (Castle, 1914); the other, that no disharmony results from race crossing.

The first corn is irritated by the finding of Steggerda and me (1929) that blacks have longer legs than whites, both absolutely and relatively to stature. Castle had previously[1] criticized me for finding a difference in leg length between Negro and Amerind. While in our Table 67 the difference in absolute leg length between blacks and whites is not much greater than the probable error of the means, the differences in relative leg length amount to 2 per cent., which strikes us as considerable, as anthropometric differences go. Also, the superiority of blacks in length of the leg and its segments is shown in all the other germane tables, namely, relative kneeling height, stature minus kneeling height and tibiale height (length of lower leg + foot). The difference between blacks and whites in these tables is consistent and in some cases considerable. The differences in absolute length of lower leg is 5 times the probable error.

That the proportions of trunk to leg do differ in different races of mankind is indisputable. If Castle will refer to Martin's "Lehrbuch der Anthropologie," 2d Aufl., pp. 411 and 412, he will find conclusive evidence of this. From his tables Martin draws the conclusion: "The relative leg-length of Negroes, Veddahs, some East Indians and Australians is especially large."

That Castle apparently still maintains his old position, though with some shifts (Castle, 1924, p. 20), is the more remarkable in view of the keen analysis of Wright (1918), who shows that in Castle's rabbits bone lengths vary to a certain extent independently. Also there are groups of bones that vary together and independently of the rest of the body. "Again," says Wright, "the bones of the hind leg (femur and tibia) form a group subject to common influences which do not affect the humerus, a bone of the fore leg."

The second irritating conclusion of mine is that in individual browns there occurs a deviation from the average proportions of leg length to arm length that is found in the parent races, white and black. Castle doubts if such a disharmony is possible. Not all the

[1] In Publication No. 320 of the Carnegie Institution.

evidence for our conclusion can be given here. It lies, in part, in the great range of dimensions of the arm and leg lengths in the browns as compared with either whites or blacks alone as shown in Tables 43 to 46, 48, 49, 52 to 54, 66 to 68, 72. That despite the usual large range the standard deviation of the browns is not always the highest of the three racial groups is probably due to the fact that the browns are the most rigidly selected of all, about half being students at Mico College.

That species hybrids can form highly variable zygotes including those that die in embryo or at a later developmental stage is well known among plants[2] in both first and especially second hybrid generations. If species hybrids, often apparently through the presence of genes with conflicting tendency, die, there is nothing extraordinary in the finding that in a less extreme cross viable but not fully harmonious progeny may be produced in F_2. That disharmonious instincts appear is easily demonstrated in dogs and poultry. That morphological disharmonies appear is well illustrated by Bryn's findings on the easily dislocated hips of Norwegian-Lapp hybrids, and the still unpublished findings of Stockard with dog hybrids.

The capacity of the organism through self-adjustment to make good some gene deficiencies is no doubt very great. But it has its limits. I have myself seen one of twins who, at birth, lacked even bilateral symmetry of the legs.

Finally, a word of protest against some misrepresenting phrases that Castle (no doubt unwittingly) has introduced into the discussion. He says, "Perhaps it is leg length in relation to total stature that puts browns at a physical disadvantage in relation to whites and blacks." This certainly distorts our conclusion. We never stated that "browns" were at a physical disadvantage; we stated precisely "some of the hybrids." We certainly never drew the conclusion that the Negro-white cross is inferior to the Negro or the whites; but we did find some cases of browns that seemed to present greater extremes—and sometimes less well-adjusted extremes—than either of the parental races. Our conclusion is not as Castle suggests it is, that the browns "are a degradation of the white race." Our conclusion is given at p. 477: "While, on the average, the Browns are intermediate in proportions and mental capacities between Whites and Blacks, and although some of the Browns are equal to the best of the Blacks in one or more traits still among the Browns there appear to be an excessive per cent. over random expectation who seem not to be able to utilize their native endowment."

[2] See Renner, in "Handbuch der Vererbungswiss.," Bd. II.

In *Nature,* No. 3177, Professor Karl Pearson publishes a critical review of "Race Crossing in Jamaica." His main complaints are based on the fact that the samples are insufficient—the adults of the 6 groups running from 50 to 93 per group. There is nothing to be said on this point except that funds and time were limited and the numbers of adults cited are all that we could, under the circumstances, secure. Whether results based on such small numbers were worth publishing is a question on which different opinions may be held. The committee thought they were worth publishing. The uniform computation of probable errors was relied upon to indicate the limits of significance (or insignificance) of the numerical results.

In regard to another matter about which Pearson complains, *viz.,* homogeneity of material, this is discussed from page 5 to 19; also pages 20 and 22. We do not recall any work of this nature where the homogeneity of the material is discussed more fully. Certainly we had in mind the desirability of genetical purity of the blacks, and think that we have eliminated the hybrids nearly as successfully as we could have done it for the "West African Negroes" to whom Pearson refers, mixed as they have been from time immemorial with Arabians and Jewish traders. If 2 or 5 per cent. of errors were made it would not have changed, we think, the essential conclusions of the work. The whites certainly included no "pass-for-whites," as they were taken from very segregated white populations.

C. B. DAVENPORT

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INDUCED PARTHENOGENESIS AND HOMOZYGOSIS

THE report of the production of homozygotes through induced parthenogenesis in Nicotiana and Fragaria, by Dr. East,[1] may justify a short review of parthenogenesis in the grouse locusts (Tettigidae). During attempts, 1915–18, to cross males and females of *Paratettix texanus* with those, respectively, of *Apotettix eurycephalus,* it was observed that the comparatively few resulting offspring were homozygous for the dominant segregate, or cross-over color patterns of the females, were themselves females and showed no trace of the dominant characteristics of the males. It was at first thought and noted that perhaps the development of the eggs had been in some way induced, or initiated, by the males of the opposite species, or by their products. However, before publication[2] it had been ascertained that the parthenogenesis

[1] SCIENCE, August 8, 1930.
[2] *Amer. Nat.,* 53: 131–142, 1919.

was in no way consequent upon the activities or products of the males. Still later[3] more than 5,000 females and 13 males of *A. eurycephalus* had been produced parthenogenetically, mostly from females which had not been exposed to males of any kind, and some of them had been carried seven consecutive generations without exposure to males.

Comparable results were obtained from the parthenogenetic breeding of *P. texanus*[4] and *Telmatettix aztecus*.[5]

All the partheno-produced individuals, including two males which were tested by further breeding, with one or two possible exceptions, proved to be homozygous for the several characteristics noted. The two tested males and several of the females, taken at random, were examined cytologically by W. R. B. Robertson. He has ascertained[6] that the homozygous pairs, respectively, of the chromosomes of the soma and oogonia lie together in early cell divisions, and not far apart, each from the other, in later cell divisions, in such position as to suggest that the second polar body division had been inhibited.[4] The second polocyte division in the grouse locusts, as in other forms, is probably normally consequent upon the entrance of the sperm, another case of "a later stage of maturation being overlapped by an early stage of fertilization."[7] In the absence of the fertilizing sperm and the resultant complete or partial inhibition of the last polocyte division, the diploidal condition is retained or restored, and if the specific or complementary genes responsible for the parthenogenetic processes are present, a chemical situation arises which conditions the initiation of development. Since it appears that any egg of these species is capable of being fertilized (those without the genes responsible for parthenogenesis require it), such educement of development may, perhaps, be considered *induced* or *artificial* parthenogenesis.[4]

It should be noted that Peacock and Harrison (1925–6)[8] advanced the very interesting hypothesis *that parthenogenesis was consequent upon hybridity*, using as a basis their work with hybrid moths from the crossing of *Tephrosia bistortata* males with *T. crepuscularia* females, and finding support from the materials used and results of the parthenogenetic breeding of the grouse locusts (*loc. cit.*). This hypothesis is probably valid, but it should be provided, in addition, that the process of hybridism may bring together specific, complementary or climaxing genes which are responsible for, or cause, as a kind of hybrid emergence,[9] the development of the unfertilized egg.

The list of instances of tychoparthenogenesis among such organisms as the grouse locusts, moths and, apparently, the plants used in Dr. East's experiments is constantly augmenting, and it is probably as yet far from complete. If a mutation, or stable, hybrid emergence, of sufficient transcendence should occur among the females of such, and since males do occasionally occur, certainly among the parthenogenetic grouse locusts, at least one long recognized major difficulty besetting the supposition of species transmutation might be considered as partially obviated.

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[3] *Kansas Tech. Bull.*, 17, 1925.
[4] *Biol. Bull.*, 66 (2): 129–155, 1929, and *Bibliographia Genetica*, 5: 27–104, 1929.
[5] *Genetics*, 13: 126–132, 1928.
[6] *Jour. Morph.*, 1930.
[7] E. B. Wilson, "The Cell," 1925.
[8] See literature cited, *Biol. Bull.*, 66: 155.
[9] SCIENCE, April 11, 1930.

MUSICAL PITCH AND PHYSICAL PITCH

THE suggestion made by W. B. White in SCIENCE of September 19, that men of science entirely abandon the pitch standardization based on making middle C equal to 256 cycles, is a healthy one. But his positive suggestion of substituting for it a standard A of 440 cycles could serve well only those acousticians who are concerned with problems of music, that is, the esthetic-artistic side of acoustics. On the other hand, telephone engineers and psychologists interested in sensation units or in hardness of hearing and like problems which have no direct relation to music ought to use 1,000 cycles as their primary pitch standard and multiples and fractions of 1,000 as their auxiliary standards, such as 50, 100, 250, 500, 1,000, 2,000, 4,000, 5,000 cycles.

The remark by Mr. White that the discrepancy between any artificial scales used by physicists and musicians becomes particularly serious in the higher regions is meaningless to musicians, since mistuning in all regions is to them a purely relative matter. Physicists, however, will no longer suffer if they wholeheartedly, instead of half-heartedly as in their middle C custom rightly criticized, emancipate themselves from the orchestra leaders. The present writer happens to be equally interested in mere hearing and in music; and he has for almost a lifetime found a complete divorce of the two methods of standardizing extremely satisfactory for both purposes. By all means let every man of science for all purposes abandon the middle C of 256 cycles. But audiometers and similar instruments ought to be standardized on a decimal scale of cycles having 1,000 as its center.

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EUSYNTHETOLOGY OR EURHETICS

IN the issue of SCIENCE for September 26, Dean Seashore presents the merits of the word *euphany* as a term to denote the "deliberate and adequate" expression of thought. The etymology of the word is satisfactory, but I can not pronounce *euphany* in a way to distinguish it from *euphony,* and it is difficult to write it so that any one can tell which word I mean. Besides, I should not like to call the distinguished dean a *euphanist.* It sounds belittling. I should prefer to call him a *eusynthetologist.* This word is made up of familiar Greek roots, and means "one who puts words together well." It lends itself to all the variations of ending which might be needed, such as *eusynthetology and eusynthetological.* Of course the word *eusyllogothetist* would provide the better order of roots, but it would sound strange and difficult. A course in advanced English composition, if it gave sufficient attention to the organization of thought, might be called *eusynthetology.*

An easy short word would be *eurhesis* or *eurhetics.* The latter could be modified into *eurhetical* or *eurheticist.* The word has the advantage of coming from the same root as our present word rhetoric, and yet its strange sound might prevent popularity.

J. F. MESSENGER

UNIVERSITY OF IDAHO

SPECIAL CORRESPONDENCE

THE TWENTY-SIXTH ANNUAL NEW ENGLAND INTERCOLLEGIATE GEOLOGIC EXCURSION

THE annual field trip of the New England geologists was held in the vicinity of Amherst, Massachusetts, on October 10 and 11. Professors F. B. Loomis and G. W. Bain, of Amherst College, and Professor C. E. Gordon, of the Massachusetts Agricultural College, were the guides.

The excursion of Friday afternoon started from the Lord Jeffrey Inn. The first locality visited was Bull Hill in Sunderland at the southern end of Mount Toby. Here an ancient lava flow from the west terminated against an alluvial fan spread from the block mountains to the east. The lava thinned out eastward as it rested upon the slope of the fanglomerate.

The excursion then continued its way along the road east of Mount Toby, halting to observe a Triassic valley filled by conglomerate. The conglomerate now forms reentrants into the crystalline rocks toward the east. Later a spur of the crystalline rocks was visited which formed a projection westward into the Triassic basin, and the contact of the Triassic sediments with the ancient basement rocks was studied. Faults in the crystalline rocks which did not cut the Triassic conglomerates had dips toward the east. The problem of the origin of the faulted eastern boundary of the Triassic basin was discussed. Was it produced by normal or by thrust faults? What was the approximate altitude of the block mountains?

The last stop of the afternoon was made in the locality of the Sunderland caves. Here a section of crumpled shales underlies a narrow wedge of conglomerate. Since the shales are conformable with overlying sandstones at either side of the wedge, it is inferred that their disturbed structure was produced by the wedge of conglomerate. A number of theories were suggested for the local folding of the shales. Some suggested a mudflow following a sheetflood in a semi-arid region. Others favored slumping attendant on the melting of winter's ice. Still others believed the conglomerate was projected out onto the plastic mud which later formed the shales by the bursting of a dam across the outlet of a lake.

After dinner at the Lord Jeffrey Inn, an evening meeting was held at the geology laboratory of Amherst College. The excellent collection of vertebrate fossils arranged under the direction of Professor Loomis attracted special attention. The discussion of the evening was led by Professor George W. Bain. The evidence concerning the origin of the eastern boundary of the Connecticut Triassic basin which had been seen during the afternoon was summarized and it was concluded that there were certain facts which pointed to compressive, rather than tensional, forces as the agents active in the formation of the Triassic basin.

Saturday morning there were two excursions. The first group visited localities in Whately, Hatfield and Northampton, where sections of the Triassic sediments were exposed and where fossil footprints might be seen.

The second party made a study of the granites and accompanying pegmatites of Whately, Hatfield and Northampton. At the northern end of Northampton reservoir a dike, approximately eight inches across, had large feldspar crystals at its center and finer crystals at its edge. It was crossed by quartz veins like the rungs of a ladder. The veins were about three quarters of an inch wide and, where they bordered on the intruded schist, penetrated the wall rock. The origin of the quartz forming the veins provoked considerable discussion. Was it segregated

from the immediately surrounding rock or was it derived from a remote source after the dike had solidified, contracted and formed the openings perpendicular to the cooling surface into which the quartz was introduced?

A granite quarry in Northampton likewise provoked considerable discussion. The basic igneous rock originally present had been intruded by later pink granite dikelets bringing with them allanite and epidote. The occurrence was quite similar to the Salem gabbro-diorite at Blueberry Hill, Woburn, Massachusetts.

The two parties were united at the luncheon served in the Tavern, Northampton. After lunch we returned to Amherst and followed the state road southward through the Notch near Mount Norwottock. At the Notch a stop was made to collect datolite and prehnite from a trap quarry and to study the faulting which formed the Notch.

Continuing our way toward South Hadley we stopped at the second trap sheet separated from the first or main sheet by southward-dipping sandstones. Here fragments of basalt occurred mingled with the conglomerate, and it was suggested that an explosive vent was present with outward-dipping slopes of agglomerate.

The excursion ended at this locality about four o'clock Saturday afternoon after two days of perfect weather and of most interesting field study. There were twenty-six colleges and institutions represented by more than seventy persons.

The excursion in October, 1931, will be held in the vicinity of Westerly and Newport, Rhode Island. The leaders will be Professors C. W. Brown and R. M. Brown, of Providence.

WILBUR G. FOYE

WESLEYAN UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE APPARATUS FOR MEASURING CATALASE ACTIVITY IN PLANT AND ANIMAL TISSUES

THE apparatus here described was designed primarily for the study of "ropiness" of bread. We find it useful also for catalase determinations in tissues. The apparatus is shown in Figs. 1 and 2. It is used as follows.

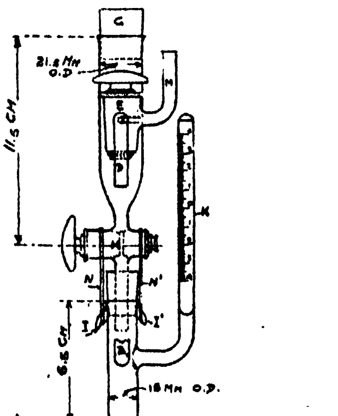

FIG. 1.

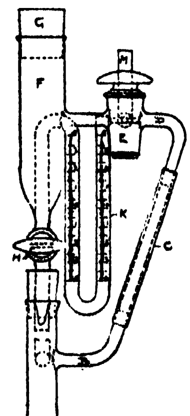

FIG. 2.

Twenty-five grams of the tissue are ground with 50 cc of tap water and made up to 75 cc with tap water. By holding the apparatus at a slant with opening of compartment A tilted upward, the fluid mass is poured with constant stirring into compartment A. The remaining particles of pulp are flushed into the apparatus with 10 cc of tap water additionally added. Stopper L is now inserted tightly. A large glass jar such as a battery jar is filled with water within half an inch from the top. The water should be nearly room temperature (within 1° F.), so that its temperature will not change appreciably during a period of fifteen to twenty minutes. Glass stopcock E is so set as to let air escape or enter through upward bent vent tube M. To hold funnel more securely in place, stopcock H is attached to glass hooks I and I[1] by means of two rubber bands, N and N[1]. The apparatus is now suspended in the water-bath by running a glass rod under the upper bend of the manometer tube K and the horizontal tube connecting F with stopcock E. This glass rod will neatly support, therefore, the apparatus at two points and will itself rest on two points on the rim of the glass jar. To establish uniform temperature conditions the apparatus remains in the water-bath for a period of ten minutes. (It is best to take the tap water for making up the tissue pulp out of the jar containing the water at adjusted temperature.) During the interval of waiting there is introduced into the funnel F 10 cc of 3 per cent. hydrogen peroxide which has been adjusted to the temperature of water-bath. The hydrogen peroxide fills funnel F almost to the side tube leading to stopcock E. There is also introduced into manometer K mercury to fill both graduated arms up to the points O. Rubber stopper G is inserted tightly into funnel F.

When the ten minutes required for equalization of temperature have elapsed, stopcock E is turned through an angle of 180°, thereby closing all communication of main body of apparatus with the out-

side but maintaining communication of main body of apparatus with funnel F through rubber tube C. Now stopcock H (immersed under water) is opened, allowing solution of hydrogen peroxide to flow from funnel F into compartment A. This compartment has the capacity of 100 cc; with 95 cc of liquid introduced there remains a 5 cc "air bubble" facilitating agitation. The whole apparatus is given a gentle shake or two and the time noted. Readings are made in millimeters on manometer K at intervals of one minute for five minutes.

If activity of the tissue is so great as to bring about a maximum reading in less than five minutes, amount of material is reduced to 10 grams or even to 1 gram. We have worked in this laboratory with materials which in amounts of .2 gram bring about a maximum excursion in less than five minutes.

To express the activity in terms of units generally acceptable we adopted the following definition: A unit of catalase activity will cause liberation in five minutes of 1 microgram (.000001 g) of oxygen per gram of tissue. We have prepared a table which enables the experimenter to quickly convert manometric readings into catalase units. This tabulation requires too much space to be given in this note. Copies of the table will be mailed by the author on request. The apparatus and accessories can be secured from The Emil Greiner Company, 55 VanDam Street, New York City.

H. H. BUNZELL

WOMAN'S MEDICAL COLLEGE
OF PENNSYLVANIA

MEASURING SLIDE FOR CLASS USE

THE ruled millimeter slide intended for use in low power dissecting microscopes, while indispensable for serious accurate work, is somewhat costly when considered for class use involving a quantity of slides. This, coupled with the liability of breakage in inexperienced hands, makes the use of the white celluloid metric rule the common measuring instrument in most elementary classes of taxonomy. The author has found an efficient substitute that can be made with ordinary photographic materials.

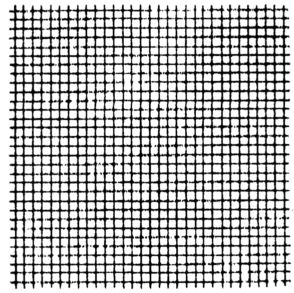

FIG. 1. Scale as it appears on finished slide.

A piece of paper is ruled with cross lines at 3-mm intervals to form a cross-ruled block 9 cm square. This is photographed on a process plate to produce an image of exactly one third the size of the original. This can be readily gauged on the ground glass with a pair of dividers set at an opening of 3 cm. The negative should be developed in a suitable contrast developer having sufficient potassium bromide to keep the lines absolutely clear while allowing the rest of the plate to become as dense as possible.

This negative printed on a slow lantern slide plate will produce a scale sufficiently accurate for any class work involving the measurement of small floral parts, seeds and fruits. A thin cover-glass bound on the slide will protect the surface from scratches. Students find scale drawings of floral parts easily made by lightly ruling with pencil their paper into squares of 5, 10, 20 millimeters or more in size and making their figures by direct comparison.

With the ordinary low magnifications used in classes of taxonomy, the essentially granular nature of the emulsion on the plate is of no serious consequence. The chief point in favor of this process is the cheapness of the slides thus produced, which in supplying a class of 20 or 30 students becomes of considerable importance.

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SPECIAL ARTICLES

THE RELATIONSHIP IN THE HEN BETWEEN THE DEVELOPMENT OF OVA, BLOOD CALCIUM AND THE ANTIRACHITIC FACTOR

OBSERVATIONS were made of the number of ova larger than 1 cm in diameter and of the blood calcium level of 30 pullets in June, 1929, which was toward the close of their first year of laying. They had been maintained for 8 months on a ration deficient in the antirachitic factor but which was supplemented, in the case of some individuals, with this factor in the form of cod-liver oil, irradiated ergosterol or sunlight through an ultraviolet-transmitting material, Cel-O-Glass.

Regardless of whether or not the antirachitic factor had been supplied, the presence of ova greater than 1 cm in diameter was accompanied by a blood calcium level between 13.0 mg and 26.7 mg per 100 cc of serum. The diameter of 1 cm was selected arbitrarily as the dividing line between developing or mature ova

and those which either had not developed or had just started to develop. When no ova greater than 1 cm in diameter were observed the blood calcium level was between 13.0 mg and 7.5 mg. Eight of the group of 30 pullets had been deprived of the antirachitic factor for a period of 8 months before killing and consequently were not actively producing eggs, although they had not started to molt. In spite of this deprivation, the presence of large ova was accompanied by a blood calcium level greater than 13.0 mg.

Ten pullets were maintained on the same basal ration for a period of four months longer; these were of the large group of which 30 had been killed and they had received their antirachitic factor throughout the eight-months laying period in the form of irradiated ergosterol, in an amount biologically equivalent to 10 times the 2 per cent. of cod-liver oil which is frequently used in poultry rations. During July and August the amount of irradiated ergosterol was doubled, but this did not stop the waning egg production associated with molting. Early in September, the feeding of 2 per cent. of cod-liver oil was begun in place of the ergosterol and continued until the end of the experiment. Observations of the ova and blood calcium of the 10 individuals were made early in the month of October when the birds were in a molting condition. Nine had no ova larger than 1 cm in diameter, and their blood calcium was 13.7 mg or below. One individual showed a blood calcium of 16.0 mg and 4 large ova were observed.

On November 5, 1929, five hens in a molting condition, but which had been exposed to all the sunlight available each day for a period of 6 weeks, were killed for observation. No ova greater than 1 cm in diameter were noted, and the blood calcium level was below 13.0 mg except in one case in which a value of 13.5 mg was obtained. Although an adequate amount of the antirachitic factor had been supplied to these individuals a high blood calcium did not prevail and ova greater than 1 cm in diameter were not present. In an earlier preliminary experiment (unpublished data) it was found that the feeding of daily doses of irradiated ergosterol to hens not in a molt, but which were not in active egg production because of a deprivation of the antirachitic factor, caused active production to take place.

The data show that the presence of large ova and high blood calcium does not always indicate active egg production, and suggest that the antirachitic factor may not be necessary in the development of ova, at least, it may not be the essential factor involved in the development, and that the antirachitic factor may not be the sole factor in causing high blood calcium.

Although a biological test, the use of the white rat, indicated that the basal ration was devoid of the antirachitic factor, it is realized that traces of this factor may have been present in the ration which permitted only a slow development of ova and occasional production of an egg.

Riddle and Reinhart[1] have shown that high blood calcium prevails in female pigeons at each ovulation period, and Hughes, Titus and Smits[2] report that high calcium prevails in hens which are in production, and low calcium in those which are molting. Our results confirm those of the above investigators with the exception that high blood calcium is not always associated with active egg production. Recently, Buckner, Martin and Hull[3] reported high calcium values for actively producing hens and for those not in active production, whereas molting hens showed a low value. Our records also confirm this report.

Whether the development of ova caused the blood calcium to rise or whether an increase in blood calcium stimulated ova formation will have to be investigated further, but it should be noted that high blood calcium was never found unless developed or developing ova were present.

It is of interest to note that Hess, Bills, Weinstock and Rivkin[4] found the blood calcium of the cod to be high at the spawning season although the eggs are without shells. In the case of the hen the presence of ova, although eggs with shells were not being produced frequently, was accompanied by a high calcium level.

Observations of 49 hens and pullets in June of this year have confirmed our previous results, and an extended report of this investigation is being prepared for publication.

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THE QUANTITATIVE DETERMINATION OF BACTERIOPHAGE

IN a recent paper[1] the writer described a comparative method for the quantitative determination of bac-

[1] O. Riddle and W. H. Reinhart, *Am. J. Physiol.*, 76: 660, 1926.

[2] J. S. Hughes, R. W. Titus and B. L. Smits, SCIENCE, 65: 264, 1927.

[3] G. D. Buckner, J. H. Martin and F. E. Hull, *Am. J. Physiol.*, 93: 86, 1930.

[4] A. F. Hess, C. E. Bills, M. Weinstock and H. Rivkin, *Proc. Soc. Exp. Biol. and Med.*, 25: 349, 1928.

[1] A. P. Krueger, "A Method for the Quantitative Determination of Bacteriophage," *Jour. Gen. Physiol.*, 1930, 13: 557–564.

teriophage. Briefly, the method depends upon the fact that with a set concentration of growing phage-susceptible bacteria and varying concentrations of phage, the time of lysis is a function of the initial phage concentration. An arbitrary turbidity standard is chosen as an end-point and the periods of time required to reduce to this level the dense bacterial suspensions in unknowns and in dilutions of "Standard phage" are recorded. (Standard phage is readily prepared in quantity. Its titer is defined in terms of arbitrary activity units and it may be kept at 4° C. for months without change in titer). By plotting the time required for the unknown to reduce the suspension to the standard end-point, the activity of the unknown solution may be calculated in terms of the activity of the standard phage with an accuracy of about ± 3 per cent.

Necessary conditions for satisfactory results are: (1) Constant temperature; (2) mechanical rocking of the test series to avoid settling of the bacteria; (3) accurate determinations of numbers of bacteria both in setting up the test and in reading bacterial concentrations during lysis;[2] (4) careful dilution technique and accurate time measurements.

Routine daily use of the method has brought out the following points in its favor: (a) Twenty to thirty unknowns may be conveniently run at once; (b) time required for the entire test is < 5 hours; (c) results are accurate to within ± 3 per cent., a figure based upon an analysis of the last 60 series run in this laboratory; (d) the procedure is definitely more reliable and is more easily carried out than either the plaque count or dilution technique ordinarily used in determining phage titers; (e) kinetic analysis of the phage-bacterium reaction predicts the relationship between phage concentration and time of lysis on which the quantitative determination depends.[3]

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THE MECHANISM OF ENHANCEMENT OF INFECTIONS BY TESTICLE EXTRACT[1]

In a series of publications Reynals has reported the observation that testicle extract to a marked degree, and certain other organs to a less extent, enhance the lesions produced by vaccine virus and staphylococcus infections.[2] Hoffman has obtained similar results with several other viruses[3] and Pijoan with a number of other bacteria.[4] A possible explanation of the enhancement mechanism was suggested by the observation that the wheals resulting from intracutaneous injections of the infectious agents with testicle extract disappeared more rapidly than those resulting from injections of the agents with inactive organ extracts. On the basis of this clue a large series of experiments has been carried out in order to determine the effect of testicle extract on the diffusion of inert substances in the skin.

For the main experiments India ink was used as the test substance. A mixture of this suspension was made with equal amounts of the various organ or tissue extracts, and 0.25 cc of each mixture was injected intracutaneously in the shaved skin of rabbits. The maximum spread of all mixtures was reached within an hour, so this period was selected for measurements. The results of a number of experiments were as follows. The average size of the area of spread for India ink-testicle extract mixture was 4.5 x 3.5 cms, while that for the control of India ink and Ringer's solution was 2.5 x 2.1 cms. The other extracts with India ink gave less striking differences. Kidney and to a less degree spleen extracts gave spreads larger than the controls, but rat and rabbit serum seemed to be without effect on the diffusion of the ink.

Another point noted, which may have a bearing on the enhancing power of testicle extract, is that the ink particles were not only spread through a wider area under the influence of the factor, but great numbers of the particles were found either in the cells or adhering to the cells. With the inert extracts the injected particles lay in the tissue spaces with no especial contact with the cells. This suggests a second effect of the enhancing substance, namely, an increased permeability of the local host cells. The activity of the testicle extract in enhancing infections as well as increasing the spread of inert particles is destroyed by heating at 60° for 30 minutes.

The tentative conclusion indicated by these observations is that the enhancing property of testicle extract on infections is at least partly due to the fact that it increases the area of spread of the injected material and increases cell permeability. The details of the experiments with a fuller discussion will be given in a subsequent publication.

D. C. HOFFMAN
F. DURAN-REYNALS

[2] A. P. Krueger, "A Method for the Quantitative Estimation of Bacteria in Suspensions," *Jour. Gen. Physiol.*, 1930, 13: 553–556.

[3] A. P. Krueger and J. H. Northrop, "The Kinetics of the Bacterium-Bacteriophage Reaction," *Jour. Gen. Physiol.*, 14 (No. 2): 223, November 20, 1930.

[1] From the laboratories of the Rockefeller Institute for Medical Research.

[2] F. Duran-Reynals, *C. R. Soc. Biol.*, 99: 6, 1928; *J. Exp. Med.*, 50: 327, 1929. F. Duran-Reynals et J. Suñer-Pi, *C. R. Soc. Biol.*, 99: 1908, 1928.

[3] D. C. Hoffman, *J. Exp. Med.* (in press).

[4] M. Pijoan, *J. Exp. Med.* (in press).

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THE AGE OF THE EARTH[1]

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BEFORE inaugurating my lectures on this generous foundation established by Mr. George Fisher Baker, I would first of all express my pleasure at having this opportunity to spend a term with my colleagues and the students of this department, which has reached such a high degree of perfection under the able, far-seeing guidance and efficient administration of your genial director, Professor L. M. Dennis. The actuality far exceeds what I had come to expect from the glowing accounts given by my predecessors.

For my introductory lecture I have chosen the problem of the age of the earth. Our earth was born from our sun. The sun, while in the giant-star stage, is supposed to have been broken up by tidal actions induced by a passing star several times more massive than itself. Originally formed in the gaseous state, the earth passed to the liquid state through loss of heat by radiation from its surface, and later into the solid state. The earth's crust and some of its individuals were formed simultaneously, followed at a much later era by the formation of biological individuals. When did the earth's crust solidify? How many years then elapsed before "life" began to develop? These questions are of interest for both the physical and the biological sciences, and an answer will be sought in the following discussion.

Astronomy teaches that the various members of the solar system have originated from the same material. This conclusion is supported by the chemical analysis of meteorites, which not only contain the same elements in approximately the same proportions as in the material of the earth, but also show them in the same isotropic combination. The two nickels of atomic weights 58 and 60 are present in exactly the same ratio in iron meteorites as in terrestrial nickel. The silicon of the stone meteorites contains the three isotopes of atomic weights 28, 29 and 30 in exactly the

[1] Introductory public lecture.

same ratio as does terrestrial silicon. There can be no doubt that the material of the earth separated from the sun's mass and the cooling of the gaseous material led to solidification and the formation of minerals.

The sand-filled hour-glass is the simplest clock. If at any spot on the earth's surface sand were deposited at a fixed rate since the solidification of the earth, then the total amount of sand deposited by this geological hour-glass would indicate the age of the earth, if we could measure the rate of deposition and the volume of the sand. Such geological hour-glasses actually exist. Rivers carry salts to the sea and, knowing the annual volume of salts carried down and the total salt content of the oceans, we can deduce the length of time this process has been in action. This interval of time corresponds to the age of the earth's crust. Even accumulations of sand itself are actually found in nature where rivers have brought sand, mud and sludge down to the sea and deposited them at the river mouth. A knowledge of the total thickness of the sediment and of the annual deposit therefore leads to a knowledge of the date of the beginning of the process. Professor Arthur Holmes, of Durham, to whom we are indebted for numerous important contributions to the determination of the earth's age, makes the following estimates for the maximum thicknesses of the sedimentary strata:

	Meters
Cenozoic Era (modern life forms)	24,000
Mesozoic Era (medieval life forms)	30,000
Paleozoic Era (ancient life forms)	61,000
Precambrian Era at least	60,000
Total	**175,000**

We can form a general idea of the rate at which these sediments have been deposited. To take an illustration used by Sir James Jeans in his very stimulating volume "The Universe around Us," since Rameses II reigned in Egypt, over 3,000 years ago, sediment has been deposited at Memphis at the rate of one meter every 1,200 to 1,500 years. With geological strata deposited at an average rate of one meter per 3,000 years, the total 175,000 meters of strata listed above would require over 500 million years for their deposition. At the much slower rate of one foot in 4,000 years,[2] the time would be about 2,100 million years.

As early as 1715 it occurred to the famous astronomer Edmund Halley that from its salt content one might calculate the age of the ocean and hence the age of the earth's crust. In that year he published a paper entitled "A Short Account of the Cause of the Saltness of the Ocean, and of Several Lakes that Emit no Rivers; with a Proposal by Help thereof to Discover the Age of the World." He showed that since the water removed from lakes by evaporation is perfectly fresh, "the saline particles brought in by the rivers remain behind, while the fresh evaporate; and hence it is evident that the salt in the lakes will be continually augmented and the water grow salter and salter." Applying the same principle to the oceans, he wrote: "It is not improbable but that the ocean itself is become salt from the same cause, and we are thereby furnished with an argument for estimating the duration of all things."

In Halley's time the necessary figures for such a calculation were lacking, but 184 years later when the same suggestion was made by Professor Joly, of Dublin, accurate data on the mass of the oceans, their sodium content and its yearly increase were at hand. The oceans contain 1,180,000 billion ($=10^{12}$) tons of water. The sodium content is 1.08 per cent. by weight, so that altogether there are 12,600 billion tons of sodium. Rivers annually contribute 35 million tons of sodium to the sea, and a simple calculation gives the age of the sea = (12,600 billion/35 million) = 360 million years. The salts which the condensing vapors of the magma directly led to the sea by volcanic processes, the amount of salt removed by wind-borne spray, and similar factors are neglected in these calculations. These factors can hardly influence the results to any very appreciable extent; but grave errors may ensue from our tacit assumption that the rate of our geological clock is the same now as it always has been. We assume that the salt additions to the sea and sedimentation proceed to-day at the same rate as yesterday and as ever. These assumptions are not necessarily true; there is definite evidence, indeed, that these regulating processes proceed now more rapidly than the average rate in the past geological ages.

We are now approaching the end of a geological period which is characterized by the formation of hills and rising continents. These conditions are favorable for the transportation of matter to the sea since the river gradients are steeper and the circulation of ground water more thorough. In the long geological ages of the past when the sea flooded the present lands and mountain elevations were consequently appreciably lower, exactly opposite considerations applied. This natural geological change is not the only reason for rejecting the assumption of a regularly running clock. Human activities tend to accelerate these time-keeping processes upon which our calculations depend. Man cultivates the land, cuts off and uproots the forests, and his industry brings large quantities of soil into the rivers. Many

[2] The present rate of subaerial denudation over North America is estimated at 15 cm, or about 6 inches, in 4,000 years.

of the largest and geologically most active rivers such as the Ohio and the Mississippi flow through cultivated and thickly populated districts where formerly forests protected the land from erosion. The sodium gained by the sea in the past must, therefore, have been less than at present, and the age of the sea as estimated from its sodium content must be set correspondingly higher. Similarly, the age as estimated from the sediments must be also increased. The late Professor Barrell even succeeded in showing a definite rhythm in geological processes. He showed conclusively that most regions of sedimentation have been subject to alternate scour and fill, and that the actual thickness ultimately preserved is merely the balance left by these two processes.

Geological methods for determining the age of the earth as thus sketched evidently do not satisfy the most important assumption that the time-indicating processes proceed now at the same rate as they have always done in the past.

The astronomer as well as the geologist is interested in the age of the earth and has also applied his principles towards the solution of the problem.

The fate of the earth is bound up with the fate of the sun. If it were possible to determine the present age and the term of the life of the sun, then the same period is simultaneously the maximum possible life of the earth. The sun loses energy at the rate of 3.3×10^{33} ergs per second, and if we knew the source of this energy, it would be possible to calculate the time required for the sun to reach its present state. Helmholtz and Kelvin believed—in agreement with the state of physical learning in their day—that the contraction of the sun provided its energy. A contraction indicates a segregation of material toward the center and a consequent liberation of potential energy which would be converted into heat. Lord Kelvin calculated that the shrinkage of the sun to its present size could have provided energy for hardly more than about 50 million years of radiation in the past.

If these calculations are applied to the calculation of the age of other stars, it soon becomes apparent that the results obtained are untenable. δ Cephei, one of the variable stars, radiates 700 times as much heat as our sun. According to the above theories, this star should have decreased in radius by 1/300 since 1788 when it was first carefully observed, but the actual contraction is not more than 0.5 per cent. of the calculated value.[3]

In addition to these and other astronomical contradictions, numerous geological arguments oppose so low an age as 50 million years for the sun and the earth. Thus the contraction hypothesis must be rejected. Stellar energy must have some other source.

To-day we know that colossal energy is stored in the nuclei of the atoms, and this knowledge is one of the most important results of our modern study of the transmutation of the elements. It is most natural to assume that this large amount of energy is the source of the radiation from the sun and stars. As the amount of stored-up energy of a star determines its length of life, modern astronomical theories through this nuclear energy just referred to arrive at a possible life-span for the sun several hundredfold that estimated by Kelvin.

The energy stored in the atomic nuclei can be set free in many ways. Radioactive decay, the dissociation of heavier into lighter atoms, sets free a comparatively small quantity of heat, although even this is many times greater than the heat developed by a normal chemical reaction. For example, the heat obtained from the decay of one gram of radium, which requires about 20,000 years for its practical completion, is 3.7×10^9 calories, which is equal to the heat of combustion of 500 kg of coal. Other processes, involving the atomic nuclei, supply yet larger quantities of energy, namely, syntheses of the elements from the hydrogen atom.

The nucleus of the helium atom contains four protons, and consequently the nucleus of the helium atom should be four times as heavy as the hydrogen atom. This is not the case, however, for the helium atom mass is 0.8 per cent. less than that of four hydrogen atoms. The difference is due to the fact that during the formation of the helium nucleus from 4 protons and 2 electrons an enormous quantity of energy is set free and radiated. Now according to the theory of relativity a loss in mass corresponds to a loss of energy, although this is never noticed, as a rule, in ordinary chemical reactions on account of the extremely small mass which corresponds to one erg of energy. One gram of mass corresponds to the absolutely prodigious amount of energy of 10^{20} ergs.[4] The extreme ratio between the units of mass and energy will be more readily understood from the following example.

If 100 carloads of coal were burned to carbon dioxide, then the combustion of this million kilograms of coal would set free a large amount of energy, but the loss of mass due to the release of this huge amount of energy would be equivalent to only about 1 gram. In the processes of the atomic nuclei, however, the

[3] So large a change in its radius should have caused a change in the rate of oscillation of δ Cephei, but this has not been observed. This point is discussed by Sir Arthur Eddington in his illuminating book "Stars and Atoms."

[4] According to the special theory of relativity, the relation between mass and energy is given by $E = c^2m$, where c is the velocity of light.

quantities of energy involved are so colossal that the resulting changes in mass are no longer negligible.

The difference in mass between one helium atom and four hydrogen atoms together with a number of similar values, thanks to Aston's marvelous experiments, are now known with great precision, and these enable us to calculate the energy set free by the formation of a helium atom from the four protons and in similar atomic reactions. Such syntheses are the sources of extraordinarily huge amounts of energy.[5]

Radioactive disintegration is the transformation of heavier elements into lighter ones, and is a well-studied phenomenon, but very little is known about synthesis, the reverse process.

In the Cavendish Laboratory at Cambridge and in other research institutions like Professor Harkins' Laboratory in Chicago the disruptions of the nuclei of light atoms under bombardment by alpha-particles have been studied. It was found that a minute proportion of the alpha-particles was successful in disrupting the nuclei, and some of the successful particles remained in the nucleus of the bombarded nitrogen atom. The latter lost a proton (mass 1) and gained an alpha-particle (mass 4), the actual increase in mass being 3. The nitrogen atom was thus converted into an isotope of oxygen (atomic number $7-1+2=8$). It is to be presumed that a building up or synthesis of heavier elements from lighter ones takes place on a large scale in some unknown part of the universe.

Radioactive decays and the synthesis of the elements from hydrogen constitute two sources of enormous energy that were unknown to Kelvin and his contemporaries. Furthermore, the sources of energy are not yet exhausted. The mass can even completely disappear and be converted entirely into energy. When a helium nucleus is synthesized from protons and electrons 3×10^{18} ergs of energy are released by the annihilation of only 0.8 per cent. of the mass of hydrogen involved; but if the *total* mass of hydrogen be destroyed the energy set free is 125 times as great.

Thus we recognize three sources of energy which may be responsible for the radiation of the sun and other heavenly bodies, viz., in order of magnitude: radioactive decay of the heavy elements; synthesis of the elements from hydrogen; complete transformation of matter into radiation. The ratio of the wealth of these sources is roughly 1 : 1,000 : 100,000. A uranium sun decaying to uranium lead thus can provide only a thousandth part of the energy supplied by a hydrogen sun transforming itself to helium, and only a hundred thousandth part as much as a sun whose mass is completely transformed to energy. In this way we arrive at very different values for the upper limit of the age of the earth, according to which of these possibilities is employed in our calculations. A uranium sun would have a life-period of only 100 million years; a hydrogen-helium sun would have a life of 10^{11} years, and a mass-energy sun (the third type) of 10^{13} years. The first value is certainly too small, for the earth must be younger than its parent the sun and we shall see that the earth is certainly older than 100 million years. Astrophysics also entirely supports this conclusion. Radioactive change can not be the sole source of the sun's radiation.

There are definite astrophysical arguments against the assumption that the sun's center or the material of the stars contain more than 10 per cent. of hydrogen, and these have been discussed by Eddington in his book on "Stars and Atoms." In the event that the source of the sun's energy is the synthesis of higher elements from hydrogen, the above value for its age must be reduced to 10^{10} or 10,000 million years.

The leading astrophysicists regard the assumption of atomic synthesis from hydrogen as insufficient to explain the astronomical phenomena, and they are inclined to the view that the aging of a star consists, to a large extent, in the annihilation of its original mass and its transformation into energy. The simultaneous destruction of 10^3 protons and electrons per gram of the sun's material per second would suffice to account for the loss of energy by radiation and would secure a continuation of the sun's radiation for 10,000 million years.

It is, perhaps, essential to point out here that just as Kelvin's calculations were vitiated by the less complete state of scientific knowledge at that time, so the same fate can overtake our present calculations. Science is compelled, however, to base its concepts on the contemporary state of knowledge, and nothing makes greater demands on the intuitive and critical faculties of the scientist than the estimation of how far the possible explanations of a phenomenon are exhausted, even when possible future developments are considered.

Nevertheless, and bearing this possible fate fully in mind, we now consider that the knowledge acquired from the study of atomic transformations not only constitutes one of the greatest advances of science but also very probably exhausts the possible sources of the sun's energy.

Geological methods give a lower limit to the possible age of the earth, while astrophysical methods supply an upper limit. The geological clock runs too slowly and the astrophysical too fast. One of the many beautiful achievements of radioactivity is that

[5] The accurate value, as determined by Aston, for the loss of weight when helium is synthesized from hydrogen is 0.00724 per gram of hydrogen.

it has provided us with the necessary magic clock whose accuracy and reliability leave nothing to be desired, and—for us the most important specification—whose rate has remained constant since the solidification of the earth's crust.

Single atoms of uranium and other radioactive substances explode. The number of particles exploding and decaying in unit time is strictly proportional to the number present. For instance, from 10^{15} uranium atoms (4×10^{-7} gm), 1,000 atoms decompose in 5 days; and from 10^{14} atoms there decompose 100 in the same time.

Uranium decay is the desired strictly uniform process whose velocity has remained unchanged throughout geological time, for it is the nucleus which is involved in the decay, and nuclear processes proceed independent of temperature, pressure and other external conditions. Therefore, there is absolutely no reason to believe that the process has gone forward at any different rate than at present at any period in the earth's history. The study of radioactivity with its inexhaustible applications has provided further proof that uranium and other radioactive substances have always decomposed in the past with the same velocity as at present. The decay of a uranium atom is always accompanied by the radiation of an alpha-particle. These alpha-particles, which leave the atom with a velocity of 8,800 miles per second (or about one twentieth of the velocity of light), can travel a certain distance or work on a photographic plate, color mica, glass and other substances within a certain fixed limit from their place of origin.

Beyond this distance, called the range, which in air is about 2.8 cm and in mica about 0.013 mm, the velocity is so small that the alpha-particles are powerless. In nature certain micas such as biotite and muscovite inclose minute uranium-containing crystals. The alpha-particles from these inclosed uranium atoms, in the course of geological ages, have evidently colored the mica over a quite definite area. Some decomposition products of uranium also emit alpha-particles, but these have a different velocity and a correspondingly different range so as to form a ring of different diameter in the mica. The sections of these colored circular areas exhibit the property of pleochroism under polarized light and for this reason were called "pleochroic halos." The diameters of these halos are closely related to the velocity of the decomposition of the radioactive atom from which the alpha-particles originate, as has been experimentally demonstrated; therefore, a change in the rate of decomposition of the radioactive substances during geological time would correspond to an alteration in the diameters of the halos. The halos corresponding to the various radioactive substances have in every case the same diameter, from which it can be concluded that the rate of decay has remained the same throughout the ages. Hence the decay of uranium provides us with a process going on at a strictly uniform rate. To use this rate of uranium decay as a measure of time, however, it is necessary to know two facts: (1) the total quantity of uranium that has decayed in some mineral since the solidification of the earth, and (2) the rate of that decay.

(1) One helium atom originates from the decay of each uranium atom. This helium collects in the uranium-containing rocks and its volume gives the number of uranium atoms that have decomposed since the formation of the rock. (2) The production of 1 cubic centimeter of helium from 1 gram of uranium requires 9 million years. A knowledge of the uranium and the helium content of a rock gives, therefore, its age. According to this method the age of the rocks has been computed to be 570 million years. Although the rocks store a large part of the helium which is produced in them, a small portion gradually escapes in course of time so that the values obtained by this method give only a lower limit for the age of the earth. Fortunately in addition to the helium accumulated in the rocks we may also measure another and this time a solid product which can not escape, namely, lead. Uranium decay leads also to the production of lead, and we need only determine the lead content of the uranium minerals in order to be able to calculate what proportion of the uranium has decomposed since the mineral was formed. The following table shows the rate at which uranium decays and uranium lead is formed:

Initially:	1 gm uranium	No lead
After 100 million years	0.985 "	0.013 gm lead
" 1,000 " "	0.865 "	0.118 " "
" 2,000 " "	0.747 "	0.219 " "
" 3,000 " "	0.646 "	0.306 " "

These figures refer solely to the chief quantity of uranium, namely, uranium I, which amounts approximately to 97 per cent. The lead which has originated from uranium need not be confused with any accessory lead because uranium-lead has a lower atomic weight (206) than either ordinary lead (208) or actinium-lead (207).

When this lead method is applied to a great number of uranium-containing minerals we obtain the following ages of the geological eras:[6]

[6] Holmes and Lawson calculated these ages from the uranium, thorium and lead content of minerals using their approximate formula:

Geological age	Age in years
Late Oligocene	37 million years
Permo-carboniferous	204 " "
Late Precambrian	587 " "
Middle Precambrian	987–1087 " "
Lower Precambrian	1257 " "

The lead method leads therefore to the result that the Precambrian minerals were in existence even 1,260 million years ago, and therefore the solidification of the earth's crust must have already taken place, perhaps about 1,400 million years ago.

The lead method has proved to be of great importance because its application enables us to determine not only the age of the oldest minerals but also the lower limit of the age of the earth's material and consequently of the chemical elements. The transformation of uranium into lead had already progressed to a certain point while the earth's material was still gaseous. The lead (206) so produced did not remain isolated as such, however; it had opportunity at that stage to mix with the thorium lead (208) from thorium decay and as a result common lead (atomic weight 207) was produced. Hence approximately half of our common lead was formed from uranium before the earth's materials had solidified. The ratio of all the uranium to about half of the common lead (plus the uranium lead) present in the whole earth's material must give the age of the earth's material. To a certain extent we can regard the whole earth as a colossal uranium- and lead-containing mineral. From this standpoint we consider not only the lead now existing as pure uranium lead or thorium lead, but also that other lead which *was* produced as uranium, thorium or actinium lead but has ceased to exist as such on account of mixture with thorium lead in the gas-liquid earth. Such a mixing of practically chemically identical elements, the so-called isotopes, was a common occurrence and must be the explanation for the fact that, for example, chlorine always has the same atomic weight. In whatever form chlorine occurs in nature there is always the same ratio between its two isotopes Cl (35) and Cl (37). The lead which has been produced in uranium minerals has had no such opportunity to mix with thorium lead, and consequently it has remained fixed as uranium-lead. H. N. Russell first drew attention to the fact that by such a method as the above the upper limit of the age of the earth could be calculated, but at that time it had not been proved that ordinary lead is a mixture of uranium-lead and thorium-lead. Since then Aston has succeeded by means of his mass spectrograph in showing that normal lead is chiefly such a mixture. These outlined considerations give about 3,000 million years as the upper limit of the age of the minerals and the lower limit of the age of the earth's *material.* During this huge period, it is only the few radioactive elements, decaying according to accurately known laws, that have altered; the other elements which build up the earth's constituents have undergone no change.

Formerly one was inclined to make no distinction between the radioactive and non-radioactive elements, and to believe that elements of the latter class were also transformed, although extremely slowly. Aston's beautiful experiments have shown, however, that this is not so. The heavy radioactive elements decay with an energy loss, whereas in the synthesis of the lighter elements from protons or alpha-particles energy is set free. Thus there is a basic difference between the radioactive and the non-radioactive lighter elements.

All the minerals and rocks which have been subjected to tests by the helium and lead methods have been taken from the earth's crust, since samples from the center of the earth are not obtainable. When the geochemist desires to know details of the composition of the interior of the earth, he turns to the meteorites and makes the assumption that iron meteorites correspond to the iron core of the earth and the stone meteorites to the more or less silicate layer. On account of experimental difficulties, only the helium method has hitherto been applied to the determination of the age of meteorites. The disadvantage of this method, that the helium can escape from the sample in course of time, is here without significance since the iron meteorites even when heated to a red heat lose no trace of helium. In recent years my predecessor in this lectureship, Professor Paneth, has developed the methods for helium determination to such an extent that one can measure 10^{-7} cubic centimeters of helium, and he has carried out determinations of the ages of meteorites. He has found for the iron meteorites a maximum age of 2,600 million years. This result lends additional appreciable support to the theory that the meteorites and the earth were formed from the same stellar material.

We can follow the fate of the earth's materials back for about 3,000 million years and show that, except for the few radioactive substances, the elements have undergone no change in the course of these years. How and to what extent the individual elements have appeared and disappeared in the span of about 8 million million years between the creation

$$\text{Age} = \frac{z}{x + 0.38\,y} \times 7{,}400 \times 10^6 \text{ years.}$$

They denoted by z the grams of lead present in the mineral, by x those of uranium and by y the grams of thorium. As thorium is usually associated with uranium, the thorium present must be, in practically every case, taken into account.

of the sun and the creation of the earth remains, however, hidden from us. Astronomers estimate the sun's age as about 8 million million years.

The study of radioactivity has led us to the above conclusions. Scientific research attempts to discover and to explain the connections of the natural phenomena. The most fascinating feature of such research is that the experimenter never knows whither the developments may lead. When Bequerel discovered radioactive rays, he had no idea that his discovery would lead to an efficient method for determining the age of the earth. The action of X-rays caused a green fluorescence of the glass walls of his tubes and Bequerel wished to determine whether all fluorescing substances sent out X-rays. Thus he discovered the action of uranium on a photographic plate and hence the radioactive rays. Continuing Becquerel's work, Pierre and Marie Curie were led to study the activity of uranium-containing minerals and discovered in pitchblende the presence of an element radiating much more strongly than uranium, namely, radium. The radioactive rays and radium were indeed epoch-making discoveries; but the most important contribution to the science of radioactivity was made by Rutherford and Soddy when they recognized that radioactive radiation was merely a subsidiary phenomenon accompanying the transformation of uranium and the other radioactive elements, and that it indicated a *disintegration of the atom.* They pointed out that the disintegration products must be present in uranium minerals and accumulate in the mineral in the course of time. Boltwood, who did so much for the early development of radiochemistry, studied a series of uranium minerals, and the constant ratio of uranium to lead struck him as remarkable. He concluded that lead was the end-product of the uranium disintegration and was the first to suggest that the uranium-lead ratio could be employed for the determination of the age of the earth. Simultaneously, the present Lord Rayleigh showed how the accumulation of helium in the uranium minerals furnished a method of determining their age. Experimental and theoretical researches by many workers were necessary in order to extend especially the lead method and to lead to the well-established numerical values here given.

The age of the earth according to ordinary time standards is enormous, but when compared with the age of some stars our earth is extraordinarily young. Three different astronomical methods can be applied to the calculation of the age of the stars, and all three astronomical clocks show the same time, 5 to 10 million million years. If the age of a human being is 1 second, of the human race 6 hours, then the lower limit of the age of the earth is one year, and the age of the stars is 5,000 years.

THE ORIGIN OF SOUTH AFRICAN ALLUVIAL DIAMONDS[1]

By Dr. GEORGE FREDERICK KUNZ
NEW YORK

One of the most important contributions of recent years to the technical literature on the diamond was the comprehensive and masterly treatise on "Diamond-Bearing Alluvial Gravels of the Union of South Africa," presented before the Empire Mining and Metallurgical Congress in Johannesburg in March, 1930. The author, Alpheus F. Williams, a graduate of the University of California and Lehigh University and general manager of the De Beers Consolidated Mines, is the son of the late Gardner F. Williams, the great organizing engineer who, after Cecil Rhodes had unified the mines, did much to bring about the establishment of the methods of control of the native labor that prevented the great amount of pilfering that had previously not only absorbed much of the profits of the mines, but had also damaged the market for the legitimate stones by the sale of the illicit stones. Mr. Williams's paper includes in its 169 pages some 52,000 words of text, 6 maps of the districts under discussion, 38 illustrations and an appendix listing the weight, name of finder and the location and date of discovery of 66 diamonds of 100 carats or more that have been found in the South African alluvial gravels. These 66 stones range in weight from 100 carats to 416 carats, and total 11,324 carats.

Ever since their discovery, the origin of the alluvial diamonds and the methods by which they were transported from their source to their final location have been subjects for speculation and debate. The first alluvial diamond in South Africa was found in the early spring of 1867 near the junction of the Orange and the Vaal Rivers among the bright pebbles picked up by a farmer's children. How many others had been picked up in this way and then lost or discarded no one will ever know, but fortunately this particular pebble caught the mother's eye, because of its bright-

[1] A review and discussion of the paper of Alpheus F. Williams on "Diamond-bearing Alluvial Gravels of South Africa."

ness, and she brought it to the attention of a neighbor, who became interested, and out of curiosity and in the face of considerable difficulty tried to find out what it was and its value. Naturally, gem experts were not plentiful in this remote district, and though no definite information was at first obtained, the prevailing opinion was that the stone was a topaz. However, when one of these amateur mineralogists discovered that the crystal would scratch glass, he expressed the opinion that it might be a diamond. The leading topaz advocate took exception to this, and the ensuing argument resulted in a wager of a new hat. This brought things to a point where the uncertainty must be settled, and the stone was submitted to a mineralogist resident at Grahamstown, who pronounced it a diamond of 21¼ carats, and valued it at £500. And thus, through a series of fortuitous circumstances, the diamond industry of South Africa was brought into existence.

Some ten months later a second stone turned up, more than thirty miles lower down the Orange River. During 1868 several more were picked up by natives along the Vaal River. After this beginning, for four years the alluvial diamond industry of the world centered around the gravels of the Vaal River basin, rapidly supplanting India and Brazil and the other less important producing districts. Up to this time, alluvial deposits of this kind were the sole source of supply, and the only diamonds known were "river" stones.

Late in 1870 and early in 1871 diamonds were discovered in "dry" diggings in several localities in the neighborhood of what is now Kimberley. In each case these deposits proved to be very restricted in area, of rounded or elliptical shape, not more than a few hundred feet in dimensions and of considerable depth, instead of broad and shallow as were the river diggings. Furthermore, these dry diggings, after working to a considerable depth, changed in character, and the friable "yellow ground" of the top layers gradually gave way to a soft blue green called "blue ground," and for the first time in history diamonds were found in their original matrix, of yellow, soft blue, and then hard blue.

The question immediately arose as to the relation between the river stones and the dry stones. Were they of the same or similar origin, or were the sources entirely different and independent?

The fact that the pipes of blue ground were some twenty miles from the nearest river deposits, with no diamonds in the gravels in the intervening areas, seemed to indicate a separate origin, but this was not necessarily conclusive. Another argument that carried even more weight was the fact that the characteristics of the river stones were entirely different from those of the mine stones, but later other pipes were discovered, the diamonds from which showed the same characteristics as certain of the river stones, indicating that while the river stones had not originated in the first known pipes, some of them may have come from others, and some from pipes never discovered, or from the top levels of pipes which have been discovered but are not now diamond-bearing. It is well established that the pipes are richer in diamonds in their upper levels than in the lower ones, and even though some lower levels now known are not diamondiferous, the upper levels that have been eroded away during past ages might still have supplied enormous quantities of diamonds to the gravels formed and washed away during the process of erosion. It is not even necessary to assume any great amount of erosion and lowering of the general level of the country surrounding the pipes. Kimberlite is generally accepted as being of volcanic origin. If considerable amounts of kimberlite emerged from the pipes and covered the surrounding territory, as is not infrequent in volcanic outpourings, even more kimberlite might have been raised to the surface than was left in the pipe, and it might also have been richer in diamonds than that remaining in the pipe, or less so.

The quantities of material available in the diamond pipes centered the main working of the industry on the mine product, and the output of the alluvial deposits soon took a secondary place. Although the extent of the alluvials was widened from time to time by new discoveries, no important developments were made until 1908, when diamonds were found in the sands along the coast of South West Africa, then a German colony. In 1911 rich discoveries were made in western Transvaal, and the territory worked gradually increased, but without further outstanding developments until the discovery of the Lichtenburg fields early in 1926. Late in the same year the coastal territory again came into prominence with the discovery of the phenomenal deposits in Namaqualand, at the mouth of the Orange River. As a result of these last two discoveries the alluvial output of South Africa in 1927 was over 49 per cent. of the total output by weight, and over 50 per cent. of the total value, while in 1928 it was over 48 per cent. by weight and over 66 per cent. by value; previous to this, these proportions had for many years averaged about 10 per cent. by weight and 22 per cent. by value. These enormous increases in the alluvial output naturally created a proportionate increase in interest in the character and origin of the alluvial stones, particularly those of these two exceptional districts.

After an exhaustive review of the contributing agencies, such as weathering and erosion, and of normal drainage and flood drainage in the transportation

of weathered material, Mr. Williams expresses the opinion that "most of the diamonds found in the gravels of South Africa originally came from the disintegration of kimberlite deposits, but that this origin may not apply to all the diamond-bearing gravels in other parts of Africa, or in other parts of the world."

Taking into consideration the number of known diamond-bearing pipes and the possibility of others as yet unknown, the diamond content of the kimberlite of the various mines and particularly the fact that the diamond content of the pipes invariably decreases with depth, the amounts of kimberlite eroded in past ages from above the present ground level must have liberated enormous quantities of diamonds. In the Premier mine alone, operations to date have produced more than a *ton* of diamonds from each hundred feet of depth of the pipe; and there is geological and paleontological evidence indicating that the original pipes penetrated several thousand feet of strata that have since been eroded away.

Weathering and erosion over long periods of time liberated the diamonds from their matrix in these pipes, and the products of erosion were carried off by the streams draining the area, slowly during periods of ordinary rainfall and more rapidly in flood periods. As erosion proceeded more rapidly in some sections than others, the topography of the country was changed, and partly due to this and partly due to the deposition of erosion products in those portions of the streams where the current was less swift, the beds of many streams were gradually shifted, and the boundaries of the various drainage areas were changed. These changes were also affected by any changes of level due to earth-lift or depression that took place during this time. Particularly in those portions of the drainage area where active silt deposition was taking place, heavy floods were liable to make considerable changes in the stream path. In this way gravels and silt that had originally been deposited in one place were transported to other areas. Thus the eroded material was gradually shifted from place to place; some portions were left at the original location, while other portions were flushed to new locations at various periods; the remainder finally reached the sea, to be distributed up and down the coast by ocean currents and washed up on the shore by wave action.

The normal rate of transportation of solid material in moving water is dependent on the velocity of the water, the size of the particle and its specific gravity. The rate of progress of finely divided, suspended silt is equal to the speed of the water carrying it, but when the size of the particles of solid is such that it can no longer remain in suspension, movement progresses only by washing and rolling along the bed of the stream. Under such conditions the rate of progress depends on a number of conditions. Fine material moves faster than coarse; smooth, rounded stones move faster than rough or flat ones; material of high specific gravity, like the diamond, would tend to sink below ordinary gravel and sand, and would move slower, unless the current were sufficiently turbulent to wash everything along together. In addition to these variables there are others that are imposed by the character of the country through which the diamonds are being transported. Clefts and fissures in the rock along the stream bed catch stones and hold them, unless the increased turbulence of high water or the gradual disintegration and erosion of the rock sets them free again. In limestone and dolomitic areas, pot-holes of all sizes form temporary or permanent traps. These and many other hazards make the diamond's journey to the sea a long and tedious one, and only a fraction of them eventually reach the final destination. Many remain along the way, trapped in a rock crevice, a gravel bar or a pot-hole, or washed out on a flood plain. Others, particularly the small and faulty stones, perish on the way, unable to stand the cruel grinding and battering that serves only to put a nice polish on a larger and more perfect stone, or possibly slightly round its sharp edges and corners.

Although the edges and faces of many alluvial stones are as sharp and smooth as of those recovered directly from kimberlite, in general the alluvial stone shows the effects of abrasion in chipped and rounded edges and corners, and in faces pitted and marred by percussion marks. The degree to which the stone shows these effects is usually considered a measure of the distance through which it has been transported, but this is not always true. The wear on a diamond is not necessarily a measure of the distance it has traveled, but rather of the time occupied by the journey and of the amount of punishment to which it has been subjected (in pot-holes, etc.) during the transportation. In a pot-hole where the percentage of diamonds in the gravel was high, abrasion of diamond on diamond might give considerable wear, where with only a small percentage of diamonds the wear from the gravel alone would be small and might not even be apparent.

THE LICHTENBURG DIAMONDS

Although the main production of alluvial diamonds in South Africa continued for many years to come from the immediate vicinity of the original discovery, near Hopetown on the Orange River, other producing districts of less importance were gradually added, some at considerable distances. Shortly after the discovery of the kimberlite pipes, the mining industry was consolidated into a few large companies, but in

contrast with this, the alluvial industry remained unorganized and in the hands of thousands of individual diggers. Production increased slowly, and it was not until 1913 that it passed 200,000 carats. During the war years production declined and did not again equal the prewar output until 1919. From 1919 to 1925 production fluctuated between 200,000 and 300,000 carats annually. Early in 1926 the Lichtenburg discoveries increased the output rapidly to 800,000 carats for the year, and to the high-water mark of 2,300,000 carats in 1927, after which there was a decrease.

In general, alluvial stones grade better than the average run of mine stones, both in size and quality. This is due to the rough treatment to which they have been subjected during their transportation, which broke up the faulty stones and washed away the smaller sizes. In this respect the Lichtenburg diamonds differ from those of other fields, for they include many small, broken and faulty stones. This is well shown by the average value of the stones recovered, from various areas. While the average value per carat of stones from the Cape Province and Orange Free State runs from 100s. to 250s., the average for the Lichtenburg stones is about 50s. per carat. This may be accounted for by the peculiar conditions under which the gravels were deposited. The Lichtenburg area is dolomitic in character, and the gravels were deposited in a network of gullies and pot-holes in the dolomite in such a way that they were largely protected from further transportation. Because of the number and size of the gullies and pot-holes, their contents were not subjected to the same amount of churning and washing as would be the case in the ordinary small pot-hole, and as a result most of the contents remained intact, while in a small pot-hole subjected to violent churning by the river current, the smaller stones and the broken fragments of faulty stones would be washed away.

From the various facts that have been established concerning the alluvial gravel deposits in the western Transvaal, Mr. Williams has constructed a theory as to what occurred before and during the transportation of the diamonds and their associated gravels into the areas in which they are now found.

The head waters of the Orange and Vaal Rivers apparently extended well into the territory that is now drained northward into the Limpopo River. After erosion had proceeded for a sufficient time to produce an extended peneplain, earth movements tilted the strata, and erosion again moved large quantities of the material southward. It was at this time that the diamond-bearing gravels were first transported into the areas in which they are now found. By the time the rivers reached the dolomitic area they must have been of considerable size, and in the early stages must have passed through this country as torrents, carrying all their eroded material with them and depositing it in lower areas where the velocity of the stream was less. The gravels as they are now found rest on a bed originally cut by a river running under quite different conditions from those existing at the time of the deposition of the gravels. The change from a torrent to a moderately slow river must have occurred gradually, because the change depended on the general erosion of the country at the same time. It was at the end of this latter period that the bedrock of the river was so altered as to be able to trap a large amount of diamond-bearing gravel in its gullies and pot-holes.

Whether the gravels transported through the dolomitic area during the earlier period carried diamonds can not be definitely established, but there seems no reason to the contrary, and the assumption that they did would explain many of the problems involving the variation in type, size, quality and quantity of the stones found further down the river system, as well as at the mouth of the river.

The transportation of material by this river system toward the south and southwest continued until some change, either in earth-movement or the encroachment of the erosion of the rivers to the north, altered the direction of the flow and turned the drainage northward.

From many pages of evidence collected by himself and quoted from other authorities at too great length to include here, Mr. Williams has evolved the above explanation and reached the conclusion that the diamonds found in the Lichtenburg area came originally from gravel deposits or igneous formations located somewhere in northern Transvaal, or even to the north of this country. This, however, does not necessarily mean that there exist to-day in that section any diamond-bearing formations of commercial importance. The gravels as they are found to-day are the concentration product of erosion acting over many geological ages, and the original source may have been of very low grade.

The Namaqualand Diamonds

In 1908 diamonds were discovered along the coast of German Southwest Africa, north of the mouth of the Orange River, in such quantities that a year later production was at the rate of half a million carats a year, and five years later was three times that amount. This was the first important discovery of alluvial diamonds at any appreciable distance from the original discovery near Hopetown. Late in 1926 Merensky and his coworkers discovered the phenomenal coastal deposits of Namaqualand, just south of the mouth of the Orange River—the most outstanding dis-

covery in diamond history, and, following the Lichtenburg discovery made a few months earlier, completing the most dramatic year the industry had ever experienced. Although several thousand carats were recovered in prospecting operations in 1926 and 1927, no active production from this new field was undertaken until 1928, when the output for the year exceeded 900,000 carats, valued at over £7,600,000.

The problem of the origin of the Namaqualand diamonds to a considerable extent begins where that of the Lichtenburg area ends.

Shortly after the discovery of the coastal diamonds of Southwest Africa, a theory was proposed that they had been washed up on the shore from a disintegrating submarine pipe somewhere off the coast. In the light of later information, particularly after the Namaqualand discoveries, this theory was abandoned in favor of one to the effect that these diamonds had a source the same as or similar to the inland alluvial deposits, differing only in that while the inland deposits had been dropped at various points along their courses, the coastal deposits were formed by the material that the rivers had succeeded in carrying clear to the mouth, later to be distributed up and down the coast by ocean currents and washed up on the shore by wave action. The remaining difficulty was to determine whether this transportation had been effected by the Orange River system alone or its ancient equivalent, or whether its work had been supplemented by the Kamma, Buffels and Groen Rivers, thus forming several sources of distribution instead of a single one. As has already been pointed out, there is evidence that in past geological times the drainage basin of the Orange River system extended well beyond its present limits, and while there is less actual evidence to support it, it is not unreasonable to assume that the mouth of the river has not always been where it is at present. This too might furnish more than one source of distribution. The diamond content of the marine terraces adjacent to the present mouth, however, seems to indicate that for a very long period the mouth could not have been many miles distant from its present position.

After careful consideration of all available evidence, Mr. Williams arrived at the conclusion that the coastal diamonds of both Namaqualand and Southwest Africa originated in the igneous rocks of the drainage basin of the Orange River, or its ancient equivalent; that after liberation by erosion they were transported by the river to the sea, and that after being deposited in the sea they were distributed up and down the coast by ocean currents and washed up on the shore line by wave action. During and subsequent to the time of the deposition of the diamonds along the shore there was a general coastal uplift, which resulted in the formation of a marine terrace. Apparently the Merensky deposit was the oldest of the marine terraces, only a portion of which remains. A very rich terrace of considerable extent was formed by the original deposition, but much of this was later washed away by successive floods, leaving only the fragments, of which the Merensky deposit was the chief one. The diamonds and gravel washed away from the original terrace were deposited in new areas along the coastal belt, or were again washed out to sea, where some may have been lost, and the remainder was again washed up along the shore line, and by subsequent earth-lift became a terrace of later age, although much of the material in it was derived from the original terrace. Mingled with the older material was the newer material brought down by the flood that washed out the original terrace. Mr. Williams thinks that there have been at least three and possibly four such periods, during which diamonds were concentrated along the shore line and later elevated into marine terraces. Although the various uplifts were apparently quite uniform in their extent, the erosion which partially destroyed the terraces was decidedly erratic in its action, leaving the terrace almost unaffected at one point but completely destroyed at another.

This is the story, as traced by Mr. Williams, that accounts for the formation of the Merensky terrace, which with its adjacent gravels had yielded, up to the beginning of 1930, more than a million and a quarter carats of as fine diamonds as the world has ever seen, valued at more than £10,000,000, as well as the other, though less richly seeded terraces up and down the coast of Southwest Africa and Namaqualand for a distance of several hundred miles.

The reviewer states that in the transportation of the diamonds from the interior to the sea, the conditions at the mouth of the river form one of the most important features, and in this connection he desires to emphasize certain factors that have an important bearing on the question. When the fresh water of a river meets the salt water of the sea, the salt causes the deposition of the silt suspended in the fresh water, and this gradually builds up a sand bar at the mouth of the river, which serves as a dam. This action is a familiar one in all large rivers carrying a large amount of suspended material, such as the Mississippi and the Hudson. During the seasons of ordinary flow in the Orange River the transportation of the gravel with its associated heavier minerals, such as diamond, garnet and ilmenite, was slow, and such as did reach the mouth from the upper river accumulated behind the bar. In seasons of moderately high water the transportation was more rapid, but the bar at the mouth of the river held back the transported material from the

sea. In time of heavy flood, when the rush of water was sufficient to wash out the sand bar, the river flow carried down not only the additional amount of material for which the rapid current furnished the necessary carrying power, but also flushed out more or less gravel from the gravel bars that had formed along its course, as well as that which had accumulated behind the sand bar at the mouth, and carried it all out to sea. The sand bar was also subject to attack from the ocean side, by heavy storms at sea; these storms not only furnished the means of destroying the sand bar and for the time being opening the mouth of the river for the free transportation into the sea of the gravel and diamonds accumulated behind the bar, but also served to distribute the diamond-bearing gravel along the coast, to the northward in the case of a storm from the south or southwest, and to the southward in the case of a storm from the north or northwest. In this way the diamonds were carried many miles both to the north and the south of the mouth of the river. The carrying capacity of the storm water for the diamonds was increased by the fact that the turbulent water along the shore line was heavily charged with suspended sand, and the buoyancy of the diamonds in this sand-water was proportionately increased, because of its higher specific gravity.

Once deposited in the sea, the diamonds and gravel, under the influence of storms, ocean currents and wave action, were not only distributed up and down the coast and washed up on the shore line, but the constant riffling action of the waves supplied a concentrating action, with the result that the larger stones were deposited close to the river mouth, while the smaller ones were carried farther up and down the coast.

SCIENTIFIC EVENTS

ANTHROPOLOGISTS AT THE WELLCOME MUSEUM

The British Medical Journal reports that a reception for the members of the Royal Anthropological Institute and other bodies interested particularly in African races and culture was held at the Wellcome Historical Medical Museum on October 10, Dr. Henry S. Wellcome, the museum's founder and director, acting as host. After making a tour of the museum, which includes an exposition of the healing arts as practised among primitive peoples, the visitors were addressed by Lord Lugard, formerly Governor-General of Nigeria, and now British member of the Permanent Mandates Commission of the League of Nations. The interest which had been shown in the welfare of subject races during the past few years, said Lord Lugard, was one of the most remarkable phenomena of the twentieth century, but in reality it had been growing ever since the abolition of the oversea slave trade. In his own acquaintance with the lawless savage Lord Lugard had found that in fact tribal organization exercised an effective discipline, and created a strong patriotism for the local community and an unswerving loyalty to the chief. Tribalism had its own code of civil and criminal law, and had evolved among other things a system of land tenure. He emphasized the need for that first task of the anthropologist, the study of existing institutions among primitive peoples. To that end Dr. Wellcome's extremely interesting museum, illustrating the practice of medicine throughout the world from the earliest ages, makes a great contribution. Lord Lugard linked it with the ethnological museum in the Lateran Palace at Rome, which showed in contrast the earlier conditions of primitive savagery and the achievements of to-day, thanks to missionary effort on various lines, including educational and medical. Such collections conferred great benefits on both the white man and the black, and would assist in solving the problem of race relations in the future. Professor J. L. Myres, president of the Royal Anthropological Institute, also expressed to Dr. Wellcome the feelings of gratitude with which anthropologists regarded one of the most stimulating museums in the country. It was a museum where the objects themselves were of extraordinary interest; but what gave them their peculiar value was that they were all eloquent in their selection, arrangement and description of the continuity and development of one of the noblest of applied sciences that mankind had at its disposal. Other speeches were made by Dr. C. S. Myers, director of the National Institute of Industrial Psychology; Dr. H. J. E. Peake, vice-president of the Royal Anthropological Institute, and Mr. T. A. Joyce, deputy keeper of the department of ethnography in the British Museum. Dr. Wellcome, in a few sentences in reply, explained how, soon after he began collecting, the idea of assisting research workers and students took possession of his mind, and he gradually formed a museum which visualized, as a museum should do, within its particular sphere, the failures and mistakes as well as the successes of the past.

WILD LIFE IN CALIFORNIA

IN an effort to preserve accurate records of the distribution of wild life in the Lassen Park area of California before further changes incident to its conversion into a public domain take place, the University of California Museum of Vertebrate Zoology has published a report extending to 595 pages.

This report, which represents almost two years of observation in the field by 12 members of the staff of the museum, is based upon a total of 3,592 specimens collected for study, including 496 reptiles and amphibians, 1,601 mammals, 1,453 birds, and 34 sets of birds' eggs, for the most part with nests. In drafting the report consideration has been given to 387 different kinds of vertebrate animals, from meadow mice, water dogs and humming birds, to bear, beaver and the California condor.

The strip of territory included in the survey is 24 miles wide and 124 miles long, or an area of 2,976 square miles, ranging from an altitude of 300 feet or less in the Sacramento Valley floor, to the great basin platform at an altitude of 5,300 feet, and the top of Mt. Lassen at 10,451 feet. The north line of the area runs roughly from a point 12 miles north of Red Bluff on the west side of the Sacramento River, to a point about seven miles north of Red Rock Post Office, just inside the California-Nevada boundary. The south line runs roughly from Tehama on the Sacramento River, to the California boundary about where Smoke Creek crosses the boundary.

During recent years the University of California, in the development of a faunal survey of the Pacific Coast and of California in particular, has made intensive studies of six other prescribed areas of the state.

Support for the study as well as the first field observations in the area came from a friend of the university, Miss Annie M. Alexander. The report was edited by Professor Joseph Grinnell, curator of the Museum of Vertebrate Zoology; Joseph Dixon, economic mammalogist, and J. M. Linsdale, research associate. Other collectors who added to the field material were Adrey E. Borell, Hilda W. Grinnell, Richard Hunt, Louise Kellogg, Chester C. Lamb, Tracy I. Storer, Harry S. Swarth, Walter P. Taylor and Leo K. Wilson.

The objectives kept in mind during the survey of the area were: what kinds of land vertebrates are present, the frequency of observed occurrence and relative abundance of these kinds, the local or habitat distribution of each kind, the factors which determine the presence and habitat distribution of each kind, the annual cycle of activity of each kind in the section, and a method of analyzing vertebrate animal communities and successions.

Explanation is made that the work has been published by the University Press, not as a popular guide, but as a scientific record of the wild life of the area for the use of naturalists and students.

REGIONAL REORGANIZATION OF THE U. S. BIOLOGICAL SURVEY

FIELD workers of the U. S. Biological Survey engaged in cooperative campaigns for the control of injurious rodents and predatory animals will be grouped, effective on January 1, 1931, in four regions, according to an announcement made on November 11 by Dr. Paul G. Redington, chief of the bureau. The Secretary of Agriculture has approved this regional plan of organization.

The grouping, with each region in charge of a supervisor, will coordinate more closely the work of the bureau throughout the country. Each supervisor will be in contact with the state leaders in his region, and also with the administrative heads of the bureau in Washington.

The new regional supervisors are men who have had wide experience in the wild animal control work of the bureau. James Silver, with headquarters at Washington, D. C., will supervise Region No. 1, comprising all states east of the Mississippi River, including all of Louisiana. Mr. Silver is at present leader of the bureau's eastern rodent control district, which occupies approximately the same area as the new region.

Region No. 2 will be supervised by Leo L. Laythe, with headquarters at Denver, Colorado, and will cover the states of Montana, Wyoming, South Dakota, Colorado and Utah. Mr. Laythe is at present state leader of predatory animal and rodent control for the Biological Survey in Colorado.

Region No. 3, with headquarters at Portland, Oregon, will include the states of Washington, Oregon, Idaho, Nevada and California. Ira N. Gabrielson, at present state leader of rodent control for the Biological Service in Oregon, is the new supervisor.

Don A. Gilchrist, leader of predatory animal and rodent control for Arizona, will be in charge of Region No. 4, comprising the states of Arizona, New Mexico, Oklahoma, Arkansas and Texas with headquarters at Phoenix, Ariz.

The new regional supervisors will each spend some time in Washington before the first of the year to acquaint themselves with the policies of the bureau that will be effective when the change is made.

THE SECOND INTERNATIONAL CONGRESS FOR SEX RESEARCH

THE house of the British Medical Association in Tavistock Square, London, was opened for the second International Congress for Sex Research during the week of August 3 to 9 and provided admirable facilities for the meeting. The general reception for delegates preceded the official opening of the congress and provided opportunity for meeting delegates from the various countries.

Arrangements for the congress were ably handled by a British committee of some thirty-five members

with Professor F. A. E. Crew as president, Dr. B. P. Wiesner, general secretary, and Dr. A. W. Greenwood, publication secretary.

Thirty countries were represented with a total registration of approximately three hundred arranged according to numbers—Great Britain, Germany, United States (approximately 35), France, Italy, etc. Almost one hundred papers, presented both in general and in sectional meetings, brought up for discussion a wide range of interests bearing upon sex problems. Predominant, perhaps, were the biological and chemical aspects of the gonad hormones which included discussions regarding hormone production, detection methods, preparation, properties, function and interactions; both the purely biological and clinical aspects were emphasized. Perhaps next in emphasis was the influence of other endocrine glands upon sex, in particular the pituitary gland. Other interests involved dietary influences affecting sex, sex control, modifications of secondary sex characters, as well as gonads themselves, contraceptive methods, the sociological and psychological aspects as well as psychoanalysis. An afternoon of demonstrations in the Cambridge laboratories arranged by Professor F. H. A. Marshall, Drs. Hammond, Walton and many others was a pleasant and profitable feature.

Under the direction of the British committee the congress was held to a commendable scientific level and was a decided success. It has been proposed to hold the third congress in Paris in 1933.

CARL R. MOORE

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE ON THE PACIFIC COAST

SUMMER MEETING OF 1931

THE first of the new series of summer meetings of the American Association for the Advancement of Science will be held at Pasadena, California, from Tuesday, June 16, to Saturday, June 20, 1931. The California Institute of Technology, the Huntington Library and Art Gallery, and the Mount Wilson Observatory will serve as hosts. Detailed preparations for the meeting are in charge of the local committee (Paul W. Merrill, *chairman;* H. D. Babcock, *secretary*), with the cooperation of the executive committee of the Pacific Division (E. G. Martin, *chairman;* J. Murray Luck, *secretary*). The section organizations are not required to take part in this meeting, but sections and associated societies (or their western branches) will be welcome. Communications concerning organizations that plan to take part should be sent to Dr. J. Murray Luck, Stanford University, as soon as possible and carbon copies should be sent to the Washington office of the association.

THE FIRST WINTER MEETING OF THE PACIFIC DIVISION

The first winter meeting of the Pacific Division, A. A. A. S., will be held at Stanford University, California, on December 22 and 23. The Society for Experimental Biology and Medicine, Pacific Coast Branch, and the Western Society of Naturalists will meet on the afternoon of December 23 for the presentation of papers. A program of papers contributed by invitation is being organized by the latter for the afternoon of December 22.

A committee of Pacific Coast geologists is arranging a symposium on the tertiary history of California for the morning of December 23. The following subjects will be considered:

1. The tertiary orogeny of California.
2. The bearing of fossil plants on the tertiary orogeny of the state.
3. The bearing of molluscan faunas on the tertiary orogeny of the state.
4. The bearing of vertebrate faunas on the tertiary orogeny of the state.
5. Tertiary igneous activity in California.

The program, as tentatively arranged, is as follows:

Monday, December 22:

10:00—Registration, Stanford Union.
11:00—Scientific film of general interest.
12:15—Luncheon, Stanford Union.
1:30—Western Society of Naturalists. Session of papers contributed by invitation.
6:00—Dinner, Stanford Union.
An after-dinner program is under arrangement. A reception, tendered by the university, will follow.

Tuesday, December 23:

9:00—Symposium, "The Tertiary History of California."
12:15—Luncheon.
1:30—Sessions of participating societies.
6:00—Dinner.

Copies of the program will be available for distribution at the registration headquarters. Titles of papers for presentation in the Tuesday afternoon sessions will not be printed in the association program and need not be submitted in advance of the meeting.

J. MURRAY LUCK, *Secretary,*
Pacific Division, American Association for the Advancement of Science

SCIENTIFIC NOTES AND NEWS

ACCORDING to an Associated Press dispatch from Stockholm, the Nobel prize in physics has been awarded to Sir Chandrasekhar Venkataram Raman, F.R.S., professor of physics in the University of Calcutta, known for his work on the diffusion of light and the "Raman effect." The prize in chemistry has been awarded to Dr. Hans Fischer, professor of organic chemistry at the Technical Institute, Munich, known for his work on blood, especially the synthesis of hemoglobin. As has been already announced, the prize in medicine has been awarded to Dr. Karl Landsteiner, of the Rockefeller Institute for Medical Research.

A "JORDAN Anniversary Number" of *Copeia*, the journal of the American Society of Ichthyologists and Herpetologists, will be issued at the end of the year, as a tribute to David Starr Jordan, dean of American ichthyologists, who will be eighty years of age on January 19. Any one desirous of helping to make this project a success, is requested to communicate with Dr. Carl L. Hubbs, secretary of the society, at the Museum of Zoology, University of Michigan, Ann Arbor.

PROFESSOR ALBERT EINSTEIN has accepted an invitation to undertake special research work at the California Institute of Technology and Mount Wilson Observatory. He will be accompanied by Dr. Walter Mayer, of the University of Vienna, as scientific assistant. Professor Einstein expects to sail on November 30 on the *Belgenland*, which goes to California with a stop at New York. He plans to return by way of New York in February, proceeding to Oxford to fill a lecture engagement.

MR. DAVID LUMSDEN, horticulturist of the Plant Quarantine and Control Administration of the U. S. Department of Agriculture, was awarded, on October 18, the silver cup presented each year by the American Orchid Society for outstanding services in promoting orchid cultivation.

A DINNER in honor of Dr. John Oliver La Gorce was given by the trustees of the National Geographic Society in Washington on November 5 in celebration of his twenty-fifth year of association with the society. Dr. La Gorce is vice-president of the society, a life member of its board of trustees, and associate editor of the *National Geographic Magazine*. Dr. Gilbert Grosvenor, president of the society, presided.

THE Board of Scientific Directors of the Rockefeller Institute for Medical Research announces the promotion of Dr. Robert E. Steiger and Dr. Alphonse Walti from the rank of assistant to that of associate on the scientific staff.

MR. LEONARD L. ELDEN, technical adviser to the general superintendent of the Edison Electric Illuminating Company of Boston, has been appointed vice-president and member of the executive council of the United States national committee of the International Electrotechnical Commission.

DR. ELWIN E. HARRIS, for the past seven years professor of organic chemistry in the University of North Dakota, has joined the Derived Products section of the U. S. Forest Products Laboratory at Madison, Wisconsin. Dr. Harris will be engaged in the federal laboratory's investigation of lignin which has been inaugurated on an intensive basis.

KENNETH A. AMSTUTZ, formerly chemist with the Dow Chemical Company, has become assistant professor of chemistry at Miami University, Oxford, Ohio.

ON the recommendation of the scientific advisory committee, the British Empire Cancer Campaign has made a further grant of £150 to Dr. J. C. Mottram, pathologist at the Radium Institute, London; £300 to Mrs. E. K. Dawson, of Edinburgh, for the continuance of investigations into mammary cancer, and £250 to Mr. E. Nevill Willmer, at the physiological laboratory, University of Cambridge.

PROFESSOR W. L. JEPSON has recently returned from England where he spent four months in research upon flora of California problems at the herbarium of the Royal Botanic Gardens, Kew, and at the Natural History Museum, London. He was also a delegate of the University of California to the International Botanical Congress at Cambridge.

PROFESSOR WILLIAM I. MYERS, of the department of agricultural economics, Cornell University, sailed on November 13 for Porto Rico, where he will undertake an investigation of agriculture and cooperative organizations for the Federal Farm Board.

DR. ARTHUR S. EAKLE, professor of mineralogy at the University of California, is conducting a systematic survey of minerals in the Hawaiian Islands, making his headquarters with the geology department of the University of Hawaii.

DR. ROSS A. GORTNER, chief of the division of agricultural biochemistry, of the University of Minnesota, will give a series of lectures at the University of Wisconsin from December 9 to 12, under the auspices of the Wisconsin Alumni Research Foundation. The series will include two general lectures on "The Application of Colloid Chemistry to Biological Problems," and on "Biochemistry and the Problem of Organic Evolution." In addition Dr. Gortner will

lecture before specific groups on his own researches in the field of colloid chemistry and the application of physico-chemical methods to biology and medicine.

Dr. Oliver Hazard Perry Pepper, professor of clinical medicine in the University of Pennsylvania School of Medicine, will give the sixth annual Scripps Metabolic Clinic Lectures at La Jolla early in January, under the auspices of the Scripps Lectureship Endowment, to members of the San Diego County Medical Society. The meeting will be primarily in the form of lecture-clinics.

Sir Frank Dyson, British Astronomer Royal, delivered a lecture at the Sorbonne, Paris, on November 7, on "The History of Greenwich Observatory." The lecture was arranged by the Association France-Grand Bretagne.

Professor P. Scherrer, lecturer in the department of physics of the Technical Institute, Zurich, will during the first ten weeks of the term deliver a set of descriptive, experimental lectures on various phases of modern atomic theory at the Massachusetts Institute of Technology, and Professor J. A. Schouten, of the Technische Hoogeschool, Delft, Holland, visiting professor on the Rockefeller Foundation, will deliver a series of lectures on "The Geometry of Linear Displacements."

Five illustrated lectures by staff members of the Carnegie Institution of Washington will be given during November and December at 8:30 P. M. The dates and lectures are as follows: November 18, "Development of the Egg as seen by the Embryologist," Dr. George L. Streeter, director, department of embryology; November 25, "Development of the Egg as seen by the Physiologist," Carl G. Hartman, staff member, department of embryology; December 4, "Development of the Egg as seen by the Geneticist," Charles W. Metz, staff member, department of genetics; December 8, "Ancient Cave Life in Southern Nevada," Chester Stock, research associate in paleontology; December 10, "Exploration of Space," Edwin P. Hubble, astronomer, Mount Wilson Observatory.

The thirty-second annual meeting (the 168th regular meeting) of the American Physical Society will be held in Cleveland in the Physics Laboratories of Case School of Applied Science and Western Reserve University on December 30 and 31, in affiliation with Section B—Physics—of the American Association for the Advancement of Science. The Josiah Willard Gibbs Lecture will be delivered on Tuesday afternoon at 4:00 o'clock by Professor E. B. Wilson, of Harvard University.

The sixteenth annual meeting of the American Association of Petroleum Geologists will be held at San Antonio, Texas, on March 19, 20 and 21, 1931. The Gunter Hotel is to be headquarters for the convention. The San Antonio section of the association will be the host for the occasion, with the active cooperation of the San Antonio Chamber of Commerce and the local hotels. Concurrent meetings will be held by the Society of Economic Paleontologists and Mineralogists, a technical division of the American Association of Petroleum Geologists, and by the Society of Petroleum Geophysicists. Special features will be a moving picture lecture by Dr. Laurence Gould, geologist and second in command of the Byrd South Polar Expedition, and a moving-picture presentation of the making of airplane maps for oil companies.

The third International Congress of Radiology will be held in Paris at the end of July, 1931, the sections being Roentgen-diagnosis, Roentgen- and Curie-therapy, radio-biology, radio-physics, natural and artificial heliotherapy and medical electrology.

We learn from *Nature* that the fifth congress of Polish Physicists, held at Poznań from September 24 to 27, attracted more than three hundred members. The congress was divided into two sections, nearly equal in numbers—an educational section and a scientific one. The members of the latter section represented all centers of physical research in Poland, many of which were created after the recovery of the political independence of that country. The congress was held under the presidency of Professor M. Wolfke, of the Technical Institute, Warsaw. Seventy-two experimental and nine theoretical papers were presented, showing a considerable increase of scientific activity since the last congress, held at Wilno in 1928. The Physical Institute of the University of Warsaw, the director of which is Professor Pieńkowski, contributed more than twenty papers.

In regard to the White House Conference on Child Health and Protection which opened in Washington on November 19, President Hoover is reported to have said: "The governors have appointed their delegates and various mayors their delegates as well as delegates from municipalities and associations interested. So far over 2,500 delegates have been appointed. Some 16 months ago I announced the convening of this conference. A number of committees were appointed for research and investigation and now total over 1,200 members covering every field and phase of child problems. The committees will be able to lay before this conference the most complete survey ever placed before this country on all questions relating to children's health and protection covering all problems, including deficient and delinquent children, to enable

the conference to come to conclusions on the material gathered. Those conclusions will have a very important effect in the activities of states and municipalities on these problems. I do not think—I know—that there never has been so exhaustive an investigation and presentation of the subject as will be made at the conference."

McGregory Hall of Chemistry at Colgate University will be dedicated on December 5 and 6 instead of the dates given in the issue of Science for October 24. On Friday the fifth, the formal dedicatory exercises will be held in the afternoon, followed by inspection of the laboratory, a dedication banquet at 6:30 P. M., and a popular address at night. On Saturday there will be held a conference on the training in chemistry required for teaching, research, industry and medicine. The names of the speakers will be announced later.

Applications must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than November 26, for the position of toxicologist, with a salary of $3,800 to $4,600 a year; for associate pharmacologist, $3,200 to $3,800 a year, and for associate physiologist (apiculture) and associate technologist (honey), $3,200 to $3,800 a year, not later than December 10. These examinations are to fill vacancies in the Bureau of Entomology, Department of Agriculture, for duty in Washington, D. C., or in the field. Competitors for these positions are not required to report for examination.

Industrial Engineering and Chemistry reports that the government of the Union of South Africa invites applications from suitably qualified research chemists for appointment to the post of director of the Fuel Research Institute, Union of South Africa. The salary attached to the post is £1,000 per annum, increasing to £1,200. Applications, giving full information, must reach the chairman, Fuel Research Board, Department of Mines and Industries, Pretoria, South Africa, on or before January 15, 1931.

The Geneva correspondent of the New York *Times* sends further details regarding the construction of the highest international scientific institute in the world, 11,340 feet up on the Jungfraujoch. It will be started soon, as the voluntary subscriptions received from the different countries are sufficient. America has contributed to the building fund $21,700, England and Germany $20,000 each, France and Austria $10,000 each. The Jungfrau Railway Company has given $40,000 and the Swiss Alpine Club $5,000. The Swiss government has promised $10,000 and an annual subsidy of $2,000 for ten years to cover current expenses. The object of the institute is to permit scientific men from all parts of the world to make researches, at high altitude, concerning meteorology, astronomy, electricity, physiology and other sciences. During the period of building the engineers and workmen will be lodged in a modern underground hotel which will be built inside the face of the rocks so as to protect them from avalanches and heavy snowfalls which are frequent on the Jungfrau during the winter months.

The *Journal* of the American Medical Association says that the government of India has accepted the offer of the Rockefeller Foundation to build and equip an All-India Institute of Hygiene in Calcutta. Lieutenant Colonel A. D. Stewart has been appointed director-designate, a site is being acquired and all provisional plans have been made. The institute will afford opportunity for research and teaching in problems of public health with special reference to Indian conditions and will cooperate with the present Calcutta School of Tropical Medicine and the affiliated Pasteur Institute, the Carmichael Hospital for Tropical Diseases and the Leonard Rogers Laboratories. The latter has a special staff working on leprosy, kala-azar, hookworm, intestinal diseases and filariasis. The Calcutta school published more than eighty technical papers on tropical problems last year.

Plans for the establishment of a research institute to be connected with the Chiaotung University of Shanghai have been completed by the Ministry of Railways of China. College graduates will receive there the opportunity to study industrial and economic problems. The China Foundation for the Promotion of Education and Culture has given $50,000 to the funds of the new institute. A College of Natural Science containing departments of higher mathematics, physics and chemistry will also be added to Chiaotung University.

A collection of Diptera, with approximately 12,000 specimens, has been presented to Purdue University by Dr. C. F. Adams, director of the bacteriological laboratory of the Indiana State Board of Health, formerly dean and entomologist of the College of Agriculture of the University of Arkansas. Dr. Adams has retained the Mycetophilidae and a named set of the Culicidae, in which groups he will continue his studies.

It is stated in *Nature* that the Mond Nickel Company, London, has arranged three exhibits showing aspects of the nickel industry, which are available, free of charge, to colleges, technical institutions, schools, etc., in connection with conversaziones or to illustrate class or open lectures. Exhibit No. 1, illustrating "The Versatility of Nickel," was available last

year. Exhibit No. 2 illustrates "The Extraction of Nickel by the Mond Process," and consists of flow sheet, photographs, samples of intermediate and fine products, letterpress and booklets. Exhibit No. 3 illustrates "The Properties and Applications of Nickel and its Alloys," and consists of samples of products made in many different alloys, photographs, letterpress and booklets. Lectures illustrated by traveling exhibits or lantern slides are also given by members of the firm's staff.

DISCUSSION

PHYSIOLOGICALLY ACTIVE COMPOUNDS

It has perhaps become customary to associate very intense biological activity chiefly with "toxines," "enzymes" and other bodies which are the despair of the organic chemist.

This attitude may have resulted partly from the fact that pharmacologists have seldom expressed the results of their experiments in striking terms. Professor A. J. Clark[1] has recently recalculated some pharmacological data in the literature and expressed the results in what may be termed an almost sensational manner. Thus he finds that doses of acetyl-choline which I had found sufficient to cause a distinct fall of blood-pressure in a cat could only produce a concentration equivalent to 1 mg in 500,000 gallons of blood. Clark has found that even smaller concentrations may affect the frog heart and shows that the volume of the cell of the frog heart is about 3.4×10^{11} times greater than that of the molecule of acetyl-choline. "This relation in size is similar to that between a large whale (100 tons) and a midge (1/3 mg). The remarkable fact is that a few thousand of these molecules when attached to the cell are sufficient to depress its activity."

My data could have been expressed in a different way: 1 grain (originally defined as the weight of a grain of wheat) would suffice to lower the blood-pressure of more than a thousand million cats; yet this dose might not kill a single cat. Clark also calls attention to the work of Loewi which indicates that stimulation of the vagus liberates acetyl-choline around the heart cells and in this way slows or weakens the heart. I had found indications of the presence in the adrenal glands of compounds which were far more active than choline and which seemed to yield choline on chemical treatment; this observation led me to prepare acetyl-choline and so to the discovery of the remarkable physiological activity of this compound. Recently Dale and Dudley have succeeded in isolating acetyl-choline from the spleen, and Kapfhammer and Bischoff believe that they have found it in ox blood.

Dale and Richards found that histamine, a compound widely distributed in animals, is active in even smaller doses than is acetyl-choline.

Clark also calls attention to a number of other very active "drugs" (thyroxin, epinephrine and secretin) which are formed in the body and concludes, "Modern investigations show, therefore, that there is a complex system of control of the body by means of the release of drugs."

The possibilities of finding drugs useful in the treatment of diseases by the pursuit of such studies are obviously very great, but at present very little scientific work is being done along these lines. Ehrlich more than thirty years ago reproached the medical profession and those responsible for the direction of medical research for abandoning to chemists and commercial interests research in this field which he termed the "ureigenstes Gebiet" of the medical profession.

REID HUNT

HARVARD MEDICAL SCHOOL

1 *Jl. Soc. Chem. Ind.*, June 27, 1930.

SALINITY AND SIZE

In the *American Naturalist* for March–April, 1930, Federighi[1] notes the smaller size of *Urosalpinx cinerea* from the saline waters at Beaufort, North Carolina, as compared with snails of this species from the less saline waters at Norfolk, Virginia, and he refers to observations by Vernon,[2] Flattely and Walton[3] and Hubbs upon the effects of salinity upon size. Hubbs noted that "within certain limits, size is directly proportional to the salinity," while Vernon and Flattely and Walton "maintain that the more saline waters tend to restrict the size attained."

It may be of interest to note that in a little paper[4] I published in 1904 I described dwarf specimens of *Neritina virginea* in the very salt shore ponds near Port Henderson, Jamaica, West Indies, and similar dwarfs from the almost fresh water in the mouths of two rivers on the northern side of the same island.

1 Federighi, "Salinity and the Size of *Urosalpinx cinerea* Say," *American Naturalist*, March–April, 1930.

2 Vernon, "Variation in Animals and Plants," Henry Holt, 1903.

3 Flattely and Walton, "The Biology of the Sea Shore," Macmillan, 1923.

4 Metcalf, "*Neritina virginea* variety *minor*," *American Naturalist*, 38, 1904.

The dwarf forms from either region have less than half the length or breadth of the forms on the ocean shore.

Interesting experiments might be made upon this widely distributed *Neritina* to see if it is so adapted to waters of an optimum salinity that rearing it in either more or less saline water causes it to be of smaller size.

MAYNARD M. METCALF
THE JOHNS HOPKINS UNIVERSITY

MOLLUSCAN HOSTS IN NORTH AMERICA FOR HUMAN FLUKES

PERHAPS the most impressive thing to the student of trematodes is the relatively great number of digenic worm parasites affecting man that are indigenous to the Orient, Africa, India and Europe. Equally striking is the lack of fluke parasites which affect man in North America. These significant facts may be explained in terms of man's distribution during geologic time. Such facts should encourage research on our own molluscan fauna taxonomically and experimentally to determine the probability and possibility of the dangerous exotic flukes becoming established on this continent.

Has any one yet tried to infect the North American relatives of *Melania, Katayama, Oncomelania, Bulinus, Bithynia, Planorbis coenosus* or *Segmentina* with the miracidiae of man's most dangerous flukes? These genera harbor such flukes in the Old World. Does any one know whether the Japanese snail, *Viviparus malleatus,* will not carry any of these dangerous flukes? This snail is already well established in the Kern River and the irrigation ditches about the city of Bakersfield, California. There are many orientals working in close contact with these snails in California. Is any one sure that these gardeners can not infect these snails with any one of the many flukes of the Orient? Likewise *Bithynia* has been introduced from Europe and *Viviparus* and *Segmentina* also have species native to North America.

Diseases such as yellow fever, malaria, sleeping sickness and filaria are carried by two or more species of the same genus of insect and, in the case of filaria, by two different genera. The distribution of these diseases now depends on the distribution of the species of animals that can carry them. Man is no doubt still giving his diseases to mosquitoes and snails that are capable of being infected because of their relationships to the original hosts.

Many of the animal parasites of man in North America are exotic forms. The hookworm of the South is supposed to have come from Africa with the slaves. Many other worms have had a similar history. In North America, rich in trematodes in other orders of vertebrates, we find few important flukes, except those brought in by foreigners, which affect man. It may not be impossible, however, for them to become established if the proper snail host should be introduced, or if the immature stages could live in a closely related snail. Such may be a possible explanation of the human fluke, *Paragonomus westermani,* in the New World.

LLOYD G. INGLES
BAKERSFIELD JUNIOR COLLEGE

A BITUMINOUS FOSSIL PLANT FROM THE TRIASSIC OF NORTH CAROLINA

A SPECIMEN of solid hydrocarbon (bitumen), in the shape and with the external markings of a flattened tree root, was recently taken from the roof of the Cumnock Coal Mine of the Deep River Triassic Coal Field of North Carolina. This peculiar specimen is black in color, brittle and has many pores, marking the presence of former gas bubbles. The specimen was about 30 feet from a large, basic, igneous dike which cuts through the Cumnock coal seam. This igneous dike has altered the bituminous coal to natural coke (carbonite) for a number of feet on either side of the dike.

It is apparent that this bituminous fossil plant root was formed by the filling of a root cavity by the bitumen distilled from the coal in the formation of the natural coke.

Local deposits of solid hydrocarbons in the Triassic sediments or Mesozoic basalts have been mentioned by a number of scientists, as J. G. Percival, T. S. Hunt, E. S. Dana and I. C. Russell. These deposits have been cited from Gaspé, New Jersey and Connecticut. The occurrence in these localities is in amygdaloidal cavities in the cellular basalt or along joint planes in the Triassic rocks.

The source of the bitumen in the deposits in Gaspé and New England is doubtless from the igneous dikes which have picked up the hydrocarbons in their course through carbonaceous rocks. The hydrocarbons thus gained were deposited in the most accessible rock openings, the joint planes and amygdaloidal cavities. This latter type of opening does not occur in the basic rock deposits in North Carolina, since in this section of the country the Mesozoic basic rocks are entirely intrusive in character and non-cellular, but the solid hydrocarbons do locally occur along the joint planes.

There are probably many fossil bituminous plant stems in the Triassic coal field areas of North Carolina and Virginia, but as far as I know there has been up to the present no record of such discovery.

WM. F. PROUTY
UNIVERSITY OF NORTH CAROLINA

THE MEANING OF NATURAL SELECTION

IN the issue of SCIENCE for October 24 is an article on "The Organic World and the Causal Principle" in which the question of natural selection as a cause is discussed, and the fact is entirely overlooked that natural selection in the minds of most men has come to mean something different from what it did to Darwin.

The authors of the article appreciate that to Darwin it meant a rule or method according to which true causes acted, but like so many other terms, this one, according to the genius of our language, has unfortunately acquired a derivative meaning, and most people now mean by it those true causes which act according to this rule or method. It was Hobbes, I think, who stated that most discussions end where they should have begun, namely, in defining the meanings of the words used.

FRANCIS RALSTON WELSH

A CORRECTION

DR. CALMAN has called my attention to the identity of *Cancer luederwaldti*,[1] recently described from the coast of Brazil, with *C. pagurus*, the European edible crab. Its occurrence in Brazil needs confirmation. The error but emphasizes the desirability of world monographs rather than local faunas, a subject referred to by Dr. Calman in his recent address on the taxonomic outlook in zoology.[2]

MARY J. RATHBUN

U. S. NATIONAL MUSEUM

[1] *Bull.* U. S. Nat. Mus. 152: 200, pls. 86–89, 1930.
[2] SCIENCE, 72: 279, September 19, 1930.

SPECIAL CORRESPONDENCE

PROGRESS OF THE GEOLOGICAL SURVEY OF CALIFORNIA

A YEAR ago last July a geologic branch was established[1] as part of the California State Division of Mines, and $20,000 for the biennium was set aside for its work. With the many facilities of the division at hand and with the cordial support of various institutions in the state it has been possible to make a broad step in advance towards fulfilling the future plan of the work.

A ten-year program has been favored by the State Mining Board and arranged for by the state mineralogist, Walter W. Bradley, during which time it is planned that the general state geologic map, now in preparation, should be finished. The base of this map has already been issued by the U. S. Geological Survey, and the compilation of geologic data is well under way, both federal and state officials cooperating in the task.

The state geologic map will serve as a general clearing place for as many data as can be secured. It has been found that about 26 per cent. of the state is covered by published detailed and semi-detailed geologic maps, 32 per cent. by unpublished material, while 42 per cent. remains practically blank, and a large portion of the blank area has no satisfactory base maps for the field geologist to use.

Most of the area covered by unpublished data has much material sufficient for a map of this scale (eight miles to the inch) but not complete enough for publication as detailed sheets. Many areas have been worked over, and the manuscripts laid aside, never to be completed by the original authors. A large part of California has been geologically mapped through the work of the geological department of the Southern Pacific Company. Large tracts of country covered especially by Tertiary sediments have been worked intensively by various oil companies, and though the details of their findings may not be at present available for publication the general areal geology suitable for the state map will be in most cases readily available as soon as the compilation of other data has been completed.

The state geologic map is to be issued in three separate sheets, covering southern, central and northern California, respectively, each published as it is completed. The two dividing lines will probably be through the thirty-sixth and thirty-ninth parallels. It is thought that the southern sheet will probably be first to get into publication, owing to the greater percentage of work covering it, and for the reason that the mapping of blank areas in the south can be completed more rapidly than in the more mountainous and wooded northern country.

Though the preparation of the state geologic map is an important item in the work of the state survey, it is by no means to be the extent of its endeavor. Its function includes the study of the problems of oregenesis, underground water, non-metallics, geology related to engineering problems, geology of the oil fields, stratigraphy and many other phases of this great applied science. At a recent meeting of the State Mining Board the name Geological and Economic Mineral Survey was adopted as the most suitable name for this new geologic branch of the Division of Mines.

[1] SCIENCE, 70: 554, December 6, 1929.

Thus far the work undertaken by this new survey has been cooperative, especially with geologists associated with universities. The first work to be published will be a very comprehensive bibliography of the geology of California, prepared by Dr. Solon Shedd, of Stanford University. This is now in the hands of the state printer.

By giving some financial assistance to certain worthy research workers, the geological survey of the Division of Mines has been able to foster a number of extensive field investigations this summer. The Weaverville quadrangle in northern California is being completed by Dr. N. E. A. Hinds, while in southern California Dr. C. D. Hulin has been mapping the Searles Lake quadrangle, a work which supplements his bulletin on the geology and ore-deposits of the Randsburg quadrangle. The results of the work of these geologists (both members of the faculty of the University of California) will be issued as separate bulletins covering in detail the problems of their respective areas.

The Division of Mines is making it financially possible for eight graduate students to carry on the necessary field work for their advanced degrees, with the result that several important areas in the state are being mapped. These are as follows: Elizabeth Lake quadrangle, by Edward C. Simpson; Sebastopol and Duncans Mills quadrangles, by F. S. Johnson; two areas in San Bernardino County, one by John C. Hazzard and the other by Dion Gardner, and a portion of northeastern Madera County by Homer D. Erwin, all of the University of California. The geology of the southern and western part of Mono County is being mapped by Evans B. Mayo, formerly of Stanford, but now of Cornell. A large part of the San Jacinto quadrangle has just been finished by Donald Fraser, of Columbia University. Underground mining geology in Grass Valley is being carried on by Robert L. Loofbourow, of Stanford University, working under the direction of the U. S. Geological Survey in cooperation with the Division of Mines. Mr. George Green, of Stanford University, is just beginning a study of the underground geology of the coast tunnels of the Hetch Hetchy aqueduct. In addition to these special studies, Mr. Charles V. Averill, district mining engineer of the Division of Mines in northern California, is making a study of the geology of the mines of the Shasta quadrangle, correlating his work with that secured from the Southern Pacific Company. Besides these projects there are many other new plans under consideration, such as cooperation with the U. S. Geological Survey in the publication of many data already in manuscript form.

The work of the new survey is, therefore, well under way. Cataloguing of data is well in hand, the bibliography is completed and the state map is in preparation. Altogether twelve field men, together with several assistants, are contributing new data to the geology of California.

Enthusiasm for the undertaking has been met on all sides, and cooperation of all sorts has been more than cordial. We now hope that the State of California will favor the continuance of the geological study and will encourage the building up of a strong geological survey by granting in the future liberal appropriations for the work.

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SCIENTIFIC BOOKS

A History of Experimental Psychology. By EDWIN G. BORING. New York; The Century Company, 1929, pp. xvi, 699.

IT is extraordinary that there should have appeared within a single year two such important histories of psychology as Gardner Murphy's "Historical Introduction to Modern Psychology" and the present work.

In contrast with most earlier treatments of this subject, both these books are the productions of men who are intimately in touch with the enterprises of present-day psychology. As a consequence, they supply a background which the active investigator can hardly afford to neglect. And the expert in another science who would cultivate a serious acquaintance with psychology could adopt no more profitable means than that of reading either or both of these historical works.

Although the present review is of Professor Boring's book, it is not entirely outside that purpose to make a distinction between it and the Murphy history. If one is interested in obtaining information in regard to the development of some special topic of modern psychology, Dr. Murphy's book will probably offer prompter service. If, on the other hand, one is interested in the present science of psychology as the outcome of a large and intricate adventure of the human mind, then one would better turn to Boring.

Histories of psychology have been in the habit of starting out with a discussion of ancient conceptions of soul or mind. When treated in detail this is an elaborate subject and one which, unfortunately, bears no obvious relation to modern psychological research. Histories which begin with such minor issues have seldom given understanding treatment to the impor-

tant sources of present psychology. They have thus tended to make the past seem meaningless and the present trivial. Professor Boring has adopted a more fruitful procedure. Since he is interested in the history of a *science* of psychology rather than in all attempts to deal with the mind, he finds his significant starting point in the emergence of scientific modes of thought and in the development of controlled observation as a basis for such thought. Although he is clearly conscious of a continuously important relationship between philosophy and science, he believes that the essential qualities of science depend upon a clearly defined distinction between the two.

It seems probable . . . that the cleft between philosophy and science is caused by a more fundamental human individual difference than are any of the clefts between the different sciences, and that science split off from philosophy, in this personal way, largely because of the rise of the experimental method. In the first chapter of this book we have said little of the great Aristotle and more of the lesser Aristarchus, who measured the distances to the sun and the moon, and of the lesser Eratosthenes, who measured the size of the earth. These two men were experimentalists, and the contrast of the experimental with the rationalistic method shows clearly in the simple beginnings of the former. Both philosopher and scientist require imagination, but the imagination of the scientist is limited by the scope of the experiment. . . .

Perhaps nothing illustrates better the general outlook and emphasis of Professor Boring's book than the composition of his first chapter. "The Beginnings of the Scientific Attitude," "Greek Philosophy and Greek Science," "The Emergence of Observation as a Method in Science," "Early Physics and Biology," "The Rise of Modern Science," "The Development of Biological Science": these are the real sources of the present science of psychology, and it is with them that this history begins. As a result one feels from the first why and how psychology, as we now know it, came to be. In the case of most of the earlier histories of psychology nothing of the kind was true. Their authors, weighted down by antiquarian interests, have plodded a laborious, chronological trail from the forerunners of Aristotle to some convenient modern stopping point.

Scientific psychology, though not without relationship to speculation about the mind, is nevertheless the child of experimental physiology, which was in turn the child of experimental physics. As Boring says, there may be some question as to whether biological and then psychological inquiry ought to have followed the pattern laid down by physics. But he recognizes that he is writing history, and he wisely turns aside from such issues of *ought*.

The actual fact is that science was what physics and astronomy were. Scientific physiology developed because physics had provided a method for it, and physiology was scientific because it held to this method. Later we shall see that physiology gave birth to experimental psychology, at first called "physiological psychology," in much the same way that physical science gave birth to physiology.

Working in this frame of mind, Boring devotes the first long section of his history to those developments within the physiology of the first half of the nineteenth century which proved especially influential upon experimental psychology. This period is taken to be peculiarly important because it is just prior to the emergence of the independent science of experimental psychology and also because many of the accomplishments of the physiology of those years were as much psychological as physiological. Throughout the volume Boring is always striving to bring out the larger movements and more significant ideas. In his treatment of this physiological psychology of the early nineteenth century he begins with the Bell-Magendie law and then turns to the velocity of the nervous impulse. Regarding the first, he tells us that:

There is little danger of overestimating the importance of these discoveries for the physiology of the nervous system. Up to this time, the nerves had been supposed to transmit promiscuously "the powers of motion and sensation." Bell's work established the fundamental dichotomy of function which has remained the implicit assumption of almost all research upon the nervous system for a century.

Similarly, Boring notes how revolutionary was the discovery that the nervous impulse is not instantaneous. The slowness of this transmission constituted an invitation for the mechanical analysis of behavior. Like Bell's discovery, it suggested that study of human action is possible in a way that it could not be if action were the instantaneous outcome of an indivisible neural flash.

Included in the discussion of early physiological psychology are chapters on the personal equation and on hypnotism. Although the first of those topics had its origin in astronomy rather than in physiology, it had a great deal to do with the rise of the classic reaction time experiments, which soon became closely related to the problem of the speed of neural processes. Hypnotism did not come into importance in the physiological laboratory, nor has it ever received much attention from orthodox scientific investigators. Most of what we now know of the subject was, however, determined by medical men and it is presumably for this reason that the topic is treated at this

point. It is interesting to note that hypnotism is one of the foundation stones of present-day psychology which has hardly any structure erected upon it. Boring is certainly justified in describing hypnotism as an important scientific chapter of the early nineteenth century, but its importance as a forerunner of experimental psychology is a matter yet to be determined.

Although it is Boring's strong contention that the facts and problems of psychology grew up within science—especially within physiology—he clearly recognizes that experimental psychology was not split off as an independent subject until what was psychological in science at large came into contact with a philosophical psychology which since antiquity had existed as a field of speculative activity. The second section of the present history is devoted, therefore, to "The Preparation for Experimental Psychology within Philosophical Psychology." In content this topic is more like what has conventionally gone under the name of history of psychology. But from the viewpoint of a present-day psychologist, Boring handles philosophy with a peculiarly happy capacity for selection. After a brief treatment of Aristotle, he goes at once to Descartes. Then follow in turn: Leibnitz, Locke, Berkeley, Hume, Hartley, the Mills, Bain, Spencer, Herbart and Lotze. The important contributions of these men are set forth with remarkable clarity and quite fully enough for the purpose of the present book. The treatment of the development of association theory in England is much the best brief account that has come to the reviewer's notice.

There are some 670 pages of text in Boring's history and Fechner makes his major entrance on page 265. This gives an idea of the relative space given to the history of psychology after it became experimental. The story of the founding of experimental psychology is told as follows: after a chapter on Fechner there is one on Helmholtz which emphasizes his theories of perception as well as his contributions to the more restricted aspects of vision and audition; then Wundt with the Leipzig Laboratory, followed by a chapter on those three non-Wundtians Brentano, Stumpf and G. E. Müller; the period immediately subsequent to "the founding" is represented by the work of a German group made up of Ebbinghaus, Külpe and Titchener (even though the last lived his professional life in America) and a number of others such as Mach, Avenarius, Lipps, Ziehen, Münsterberg, Kraepelin and Meumann, each of whom for one reason or another lay outside of the main experimental current; a chapter on the act psychology establishes the historical origin and importance of the distinction between content and act and also prepares the way for the understanding of the functional movement later to arise in America and of the *Gestalt* psychology which is still causing excitement in both Germany and America; British psychology is regarded as important for the systematic writings of Ward, Stout and McDougall, for the contributions of Darwin, Romanes and Lloyd Morgan to animal psychology, and for the fundamental operations of Galton in the field of individual differences; and finally there is a chapter on the American pioneers, James, Hall, Ladd, Scripture, Baldwin and Cattell. All this is a long and difficult piece of writing which it is hard to characterize except in general terms. Perhaps the task could have been better done, but it is the reviewer's belief that no living man could have done it so clearly and almost simply and yet so expertly. Professor Titchener had the knowledge required for this task, but even had he undertaken it, he probably would not have done as well, because, while he was capable of superb exposition at the elementary level, he was hideously difficult when he aimed to be scholarly. But Boring has exemplified a scholarship that is definitely of Titchenerian order coupled with a directness that his master was able to employ only when he could be dogmatic.

There is much talk of personalities in this account of the early days of experimental psychology, but, as Boring points out, those days were made by personalities. The objective study of reaction times would never have been undertaken simply because some one in Wundt's laboratory thought it was a good idea. It should be of the first importance for psychologists to realize that this idea happened in the head of an American youth whose dynamic character is reflected in the fact that he was Wundt's self-nominated assistant. The introspective method would never have gathered around itself a school in America if Titchener had sought to be a congenial colleague of his American contemporaries.

When a historian comes into current events, he is peculiarly exposed to challenge, and it is Boring's treatment of the movements of American psychology which is most likely to arouse arguments. Functional psychology, experimental animal psychology and mental tests are subjects that all of us have known and fought over since the infancies of our professional lives. But before any questions of personal bias are raised, it should certainly be said that Boring has attacked these difficult contemporary and local questions with every effort to be fair. He has read Dewey and Angell on the general standpoint of functionalism and he has read them sympathetically. It is doubtful whether any careful student will be disposed to disagree with his statement of the aims and claims of these men. Nor is he wrong in pointing out that Angell's students more or less naturally drifted into

applied psychology and animal psychology. As compared with his treatment of the factual discoveries of such a group as Külpe's, his treatment of the achievements of those American experimentalists who have been motivated by a dynamic view-point is, however, very incomplete. The reviewer has the feeling that the pioneer studies of Bryan and Harter and of Book on the acquisition of skill were of substantial importance even for the development of a generalized human mind. Stratton's classic experiment on inverted vision reflected very definitely the theoretic framework of American thought. Thorndike's studies of transfer and fatigue were other influential products of the experimental operation of that larger dynamic view-point which has pervaded America and determined the nature of a large part of the investigation done here. The reviewer has similar feelings in regard to Boring's treatment of animal psychology and the mental test movement. There is an attempt to characterize these subjects, but they are, after all, treated rather as offshoots from experimental psychology than as vital ingredients. Boring recognizes in a word that animal psychology has developed into a more general approach to mind than that afforded by the study of the human subject alone, but he has not paid tribute to the large part that investigations of animal behavior have had in shaping current notions of behavior. He recognizes that mental tests are an important offshoot from experimental psychology, but he gives little stress to the really epoch-making discoveries brought about by this device. The reviewer would hazard the prediction that the discovery of the almost invariably positive correlation of intellectual capacities will sooner or later be regarded as more important even for experimental science than the number of layers which somebody can discern in consciousness. It is not to be concluded from Boring's failure to treat in any detail the development of our knowledge of skill, intelligence and work that he regards these topics as trivial. The explanation seems to lie rather in the fact that he has purposely restricted the meaning of "experimental psychology" to what Wundt meant by that expression—"that is to say, the psychology of the generalized, human, normal, adult mind as revealed in the psychological laboratory." Like Titchener before him, Boring seems to feel that experimental psychology of this type must be kept clear of issues that arise out of application or out of investigations of animal behavior which the original Wundtian theory has always found it so difficult to place. But why should one want to confine oneself to the history of what is left of the Wundtian theory? That is a difficult question. It is especially difficult when one considers that the majority of the present work is an adequate history of "scientific psychology" in a much broader sense. It is only in his treatment of American psychology of the fairly recent past that Boring's interest shows its restriction.

Perhaps the reviewer attaches altogether too much importance to the fundamental, scientific contributions made by those who, in this country, have been dominated by a dynamic and functional point of view. It was not his wish, however, as he laid down this history that Boring had said a word less about occurrences within and close to the Wundtian tradition of experimental psychology. He only wished that the author had gone under the *schools* of functionalism and behaviorism and under the more superficial characters of the movements of application and animal study in order to bring out, as he surely would have brought out, discoveries of fact and the development of theory which have already shown their importance for psychology in its largest and most general sense.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MODIFICATION IN LANTERN SLIDE PROJECTION TECHNIQUE

IN the teaching of the usual courses in physiology, difficulty is experienced in the presentation of visual material. The usual method, and perhaps the simplest, is to draw the diagrams upon the blackboard during the lecture. This takes too much of the time from a short and busy lecture hour, time better occupied otherwise. Large charts mounted on cardboard are useful but have the disadvantage of being expensive, hard to keep clean, difficult to make and bulky for storage. It is often difficult to make them large enough to be easily seen by a large class.

Moving picture films are becoming cheaper and more accessible but are still expensive, and the exact diagrams and drawings of the individual lecturer are rather difficult to prepare in this way, taking a good deal of time and labor. Alterations are not easy, and still projection is hard on film.

Lantern slides still seem to be the best medium for charts and diagrams. However, the ordinary slide prepared by photography does not pass as much light as is often required when daylight illumination of the room is desired. Darkening a room for lantern slide projection is usually a strong hint to the class to take a nap. The process of preparing

lantern slides by photography is tedious and rather difficult.

A modification of this technique has been in use in our department for some time, and the method has been very convenient for some phases of visual presentation. The materials required are a number of glass plates the size and shape of the ordinary lantern slide, drawing inks of the waterproof type and drawing instruments. The plates may be prepared by cutting up thin window glass or boiling emulsion off of old photographic plates and cutting them up. Very fine pen points and camel's-hair brushes are necessary.

After thorough cleansing of the glass surface, the desired diagram is drawn directly in ink on the glass with fine point pens and brushes, using colored inks as desired. The material to be copied may be first drawn on paper and then the slide placed over it for the ink transference to glass. Details, such as fine shading, are rather difficult to reproduce and may often be better left out. But ordinary line drawings are very easily and quickly reproduced on the slide. Any color combinations may be used and, with care, color washes are often of value.

If the slide is to stand a good deal of wear it may be made fairly permanent by dipping the slide, after the ink has dried thoroughly, in a thin clear solution of rosin in xylol. The edges of the slide may be conveniently bound in black, gummed linen tape. The rosin-xylol coating is not necessary for ordinary use, the slide resisting all but direct heavy rubbing and scratching. Slides may be rapidly and easily altered at will. Fifteen or twenty minutes should be sufficient time to prepare a slide for lecture use.

The lines of even the finest pen are much heavier than the fine shading in photographic slides and therefore stand out heavily on the screen. Full daylight may be allowed to fall on the screen without marked diminution in visibility. The lines of the drawing being the only obstruction to the passage of light rays from the machine to the projection surface, very little light is cut off and a great deal of it is concentrated on the screen. Due to this fact and to the heaviness of the lines, a blackboard may be used as a screen in a daylight-illuminated room. Even the lines in black ink stand out clearly by reason of the intense illumination about them. This makes possible modifications of the usual technique of lantern slide projection.

Manifestly, if the lecturer is sufficiently facile with chalk drawing, the method of building up diagrams as the lecture goes on is best of all. The student sees the picture grow under his eyes at the same time that word pictures are built up by the speaker. However, this takes a good deal of time. Few lecturers are possessed of the magic touch of being able to draw accurately and artistically in a short period of time while simultaneously delivering a lecture. To make this easier, the basic fundamental outlines required may be prepared upon slides and projected upon the board. Then while lecturing the speaker may quickly and easily put in the necessary additions or alterations in chalk. By virtue of their lack of reflecting power, the chalk lines are distinct from the original outlines. Altering or adding is much easier and more rapid than the building up of the entire diagram. An eraser may be run over the board and the original lines left for reference and equilibration.

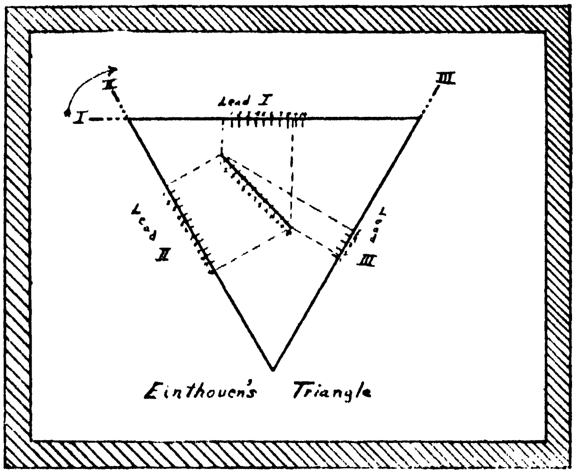

FIG. 1. Einthoven's electrocardiographic triangle. Slide may be projected on board, and after explanations, direction of heart axis may be changed by chalk alterations, simultaneously changing length of projected vectors on triangle to show effect of cardiac axis change on electrocardiographic records.

Uses of this method are numerous. Formulae for chemical equations may be thrown on the board with no figures and the necessary quantities may be written in chalk and altered to suit the problems. Outlines of the body or organs may be thrown on the screen and functions added in chalk (Fig. 1).

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HOW TO MAKE HORIZONTAL DEMONSTRATIONS VISIBLE TO AN ENTIRE CLASS

SOME class demonstrations can be seen only from above. This makes it necessary for small groups to observe them at any one time, which process takes up a great deal of the laboratory period and almost makes it impossible to show effectively such demonstrations in a lecture. At the same time those who

are not viewing the demonstration are disturbed by the walking about. A good example of such a demonstration is that illustrating the effect of dilute nitric acid on the surface tension of a drop of mercury in the presence of a crystal of potassium dichromate. Where a reflecting stereopticon is available it could be used to throw the image upon the screen, but this necessitates darkening the room. A much simpler method and one easily adaptable to almost any demonstration which is difficult for the entire class to see at one time is to place a mirror at an angle of forty-five degrees behind the demonstration and raise the whole a little above the level of the class. For small demonstrations a mirror from the five-and-ten cent stores is adequate. This can easily be held in place upon a board in which two finishing nails of the proper length have been driven at an angle of forty-five degrees, and one nail in the center set back behind these to keep the mirror from slipping.

If the demonstration is small so as to be seen with difficulty from the rear seats, a reading glass of a suitable magnification can be placed at the proper distance from the mirror. In this case the entire demonstration should be placed upon a board or platform so that it can be swung into the line of vision of those on the sides. Other modifications and applications will suggest themselves.

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SPECIAL ARTICLES

TRIANGULAR NEPIONIC COILING IN CARBONIFEROUS AMMONOIDS

A FRAGMENTARY cast of a fossil, which, except for its apparently triangular method of coiling, suggested the umbilical portion of a glyphioceran cephalopod, was collected by the writer in the fall of 1923 from the sparingly fossiliferous lower Pennsylvanian Winslow formation near Fayetteville, Arkansas. An extended search failed to yield additional material. About a year later, however, Dr. N. F. Drake, formerly state geologist of Arkansas, kindly placed at the writer's disposal several cephalopods which had been blasted out of the same formation on Mount Nord within the city of Fayetteville. Upon cleaning the material, the umbilical portions of these cephalopods showed that the coiling of their earlier whorls was distinctly triangular, although the individuals again assumed the ordinary circular method of coiling in their later stages of growth.

A canvass of the literature failed to find any reference to this phenomenon, and the questioning of a number of paleontologists over a period of several years led to the conclusion that it had not previously been observed. Because of the scantiness of the material and its rather poor preservation, as well as the unusual nature of the discovery, the writer has hesitated to record the phenomenon. Recently, however, as a result of continued questioning it was discovered that H. D. Miser, of the U. S. Geological Survey, had in 1927 collected from the Atoka formation near Clarita, Oklahoma, a number of unusual cephalopods which were sent to Dr. R. C. Moore, of the University of Kansas, for study. These specimens also exhibit this same peculiar triangular coiling of the earlier whorls. Furthermore, when this feature was called to the attention of F. B. Plummer and Gayle Scott, who are studying the Carboniferous cephalopods of Texas, they found that upon cleaning out the umbilical area of some of their specimens from the Bend group the same nepionic triangular coiling became apparent. In addition, the writer recently received from John McCormack, of the Oklahoma Agricultural and Mechanical College, a number of cephalopods from the Atoka (?) formation taken from a clay pit near Ada, Oklahoma. Among these specimens there are two individuals which illustrate perfectly this triangular method of coiling. Furthermore, although these specimens are not complete, their last preserved whorls fail to assume complete circularity, though they are somewhat more rounded than the earlier ones. Finally, in examining specimens of Bend group cephalopods in the Walker Museum collection it was found that a number of these individuals also show a definite tendency toward angular coiling in the nepionic and neanic stages, though the triangularity is less pronounced than in the other specimens mentioned above.

Additional interest attaches to this phenomenon since it is apparently confined to members of the cephalopod family Glyphioceratidae, and, as far as present information goes, largely to the genus *Paralegoceras*. Furthermore, although it has now been observed in specimens collected from a number of different localities, the extremes of which are nearly 500 miles apart, all the individuals have been found at essentially the same geologic horizon, that is, lowermost Pennsylvanian. The formations yielding the cephalopods are the basal Winslow, just above the Morrow group, at Fayetteville, Arkansas; the basal Atoka, just above the Wapanucka limestone (which carries a Morrow fauna), at Clarita, Oklahoma, and in north-central Texas, the Smithwick formation, which overlies the Marble Falls limestone (also with a Morrow fauna). The specimens from near Ada

are reported to have come from the Atoka formation also, and the general appearance of the associated specimens supports this statement. No Atoka, however, is shown in the vicinity of Ada on the new geologic map of Oklahoma. Therefore, these particular specimens may have come from somewhat younger beds than did the others.

In conclusion, it is interesting to speculate on the significance and origin of this phenomenon of triangular coiling. Aberrances of one sort or another are not uncommon in cephalopods of the phylogerontic type, but the Glyphioceratidae are simple rather than specialized ammonoids. Furthermore, these phylogerontic aberrances in most cases are also phenomena of individual old age, and not of youth, as is the case in the forms described above. In addition, if all cephalopods in their various stages of development recapitulate their ancestry, as certainly most of them do, these peculiar types point to an ancestral stage in which the adults were triangularly coiled. Not only is no such cephalopod known, however, but it is particularly difficult to imagine the existence of such a type prior to Pennsylvanian time. It therefore seems more probable that the cephalopods described in this note are pathological in respect to the manner of coiling of their earlier whorls. If the latter is the case, however, it is not a little remarkable that the same pathological feature should manifest itself in the same general type of cephalopod, at nearly if not quite the same geologic horizon, and in specimens found over a relatively large area, geographically speaking. Supporting the suggestion that the forms described above may be pathologic is the fact that normal nepionic coiling is found in most associated cephalopods. It has not yet been determined satisfactorily, however, whether some individuals of a certain species may be coiled normally and yet others of that species exhibit the triangular nepionic coiling, or whether this type of coiling characterizes all individuals of each species exhibiting this phenomenon.

The writer would appreciate additional records of the occurrence of this type of cephalopod.

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STIMULATORY EFFECTS OF ULTRA-VIOLET RADIATION UPON HIGHER PLANTS

The apparently contradictory results of recent investigators concerning the possible stimulation of the growth of higher plants by ultra-violet radiation led to the work reported briefly here. Chief among these investigators are Eltinge[1] and Sheard and Higgins,[2] who have demonstrated that ultra-violet wave-lengths above the lower solar limit, 290 μμ, are beneficial to and seem to stimulate plant growth slightly; and Popp and Brown[3] and Newell and Arthur,[1] who failed to find any stimulation whatsoever in the ultra-violet spectrum.

It appears that these varying results are attributable to differences in methods of irradiation and to other parts of the technique employed by these workers, since similar portions of the spectrum were used in the investigations.

The plants used were tomatoes and cucumbers, reported by Newell and Arthur, and Popp and Brown, respectively, to be unaccelerated in their growth by the radiation from a quartz mercury vapor arc. The experimental groups were the following:

A—Controls.

B—Plants rayed with quartz-lite filter (transmitting to 313 μμ) one half minute on the first day, increased by half a minute on each following day.

C—Plants rayed with quartz-lite filter for 9 minutes daily.

D—Plants rayed with vita-glass filter (transmitting to 289 μμ), with periods as in set B.

E—Plants rayed with vita-glass filter with periods as in C.

The plants were rayed at 100 inches from the arc through a period of five weeks, with 100 plants in each group. The populations of 100 plants as shown by statistical analysis eliminated the factor of individual variation, which had been neglected by previous workers.

It will be noted that the periods of radiation were adjusted so that at the end of the experiment the incremental and constant period groups would have received equal amounts of radiant energy; hence differences in the reactions of the plants subjected to the two methods are attributable only to the differences in the arrangement of the irradiation periods, not to differences in amounts of energy received.

In general, the results point to definite stimulation where the distance was 100 inches. In a preliminary experiment at 50 inches, when the lamp was screened with the quartz-lite filter, there were no injurious effects and there was apparently a small amount of increased growth. At 100 inches, all rayed sets showed very definitely greater growth than the controls; in both plants, the greatest amount of increase occurred in the vita-glass constant-period group, set E; here, in the tomatoes, the plants at the end of the period showed an increase 33 per cent. greater than

[1] Eltinge, *Ann. Mo. Bot. Gard.*, 15: 169–240, 1928.
[2] Sheard and Higgins, Science, 65: 282–284, 1927.
[3] Popp and Brown, *Amer. Jour. Bot.*, 15: 623, 1928.
[4] Newell and Arthur, *Amer. Jour. Bot.*, 16: 338–354, 1929.

that of the controls; in the cucumbers, the percentage of increase over the controls was about 34 per cent. Dry weight percentages of wet weight and ash weight percentages of dry weight were greater in the rayed plants than in the controls, the former as much as 19 per cent. greater in the tomatoes, the latter as much as 13 per cent. greater. Numbers of leaves were greater in the rayed plants.

It is interesting to note that the incremental method induced greater increase in growth than did the constant period method, when the quartz-lite filter was used; with the unscreened arc, the injurious effects were considerably reduced by the former method of treatment. At 50 inches, in some cases, the constant period method seemed actually to retard growth slightly, even when the lamp was screened, whereas the incremental treatment caused the plants to grow somewhat more rapidly than did the controls. The reaction in the case of the incremental method seems to be of a two-fold nature: first, a gradual adjustment to the new environmental factor, then an increased growth rate under the influence of the gradually increasing intensity of that environmental stimulus.

This work was carried out under the direction of Dr. Ernest S. Reynolds. A detailed report is to be published later.

Harry J. Fuller
The Henry Shaw School of Botany,
Washington University

HETEROTHALLISM IN PUCCINIA CORONATA

The sporidium of *Puccinia coronata* Corda, on a Rhamnus leaf, germinates by forming a short beak, pierces the outer wall and enters the epidermal cell. The sporidial nucleus usually divides before entry. In the epidermal cell the fungus grows into a primary hypha of 4 to 6 cells, from each of which a branch forms which penetrates to the subepidermal region and develops there into haploid mycelium.

The mycelium spreads between the epidermis and the palisade, forcing the two layers apart and forming a continuous mat or stroma several cells thick. From this stroma hyphae grow down between the palisade cells into the spongy mesophyll. Haustoria may be unbranched or may fork dichotomously once, twice or even three times.

On the subepidermal stroma the pycnia form at fairly even intervals. Later a similar but smaller stroma forms next the lower epidermis and a few pycnia appear on it, which open onto the lower surface of the leaf. In old infections the whole upper stroma with its pycnia may peel off leaving the palisade layer exposed.

Puccinia coronata is at least partly, perhaps wholly, heterothallic. Eight Rhamnus plants bore 1 infection each. They were carefully isolated. Seven of the 8 remained sterile, that is, produced no aeciospores. On another plant bearing 6 infections the pycniospores were well mixed. Five of the 6 produced open aecia.

The sterile infection produces aecia which reach a considerable size but they form no spores. In these sterile aecia, however, there appear at a certain stage of development cells with 2 or 3 nuclei. These cells grow irregularly and their nuclei increase in number, but sooner or later they deteriorate and die. Multinucleate cells are to be found in practically 100 per cent. of all the older sterile aecia. A few of these multinucleate cells survive to a great age. In one sterile infection 62 days old there were living multinucleate cells of monstrous size, highly irregular in form and each containing 15 or 20 nuclei.

In the fertile infection the aecia produce spores regularly. Here are to be found an abundance of cells with 2 nuclei, some with 3, very rarely 1 with 4 or 5, but never the monstrous multinucleate cells so characteristic of sterile aecia.

The point at which the sporophyte is initiated in the fertile infection would seem to be variable. A few binucleate cells have been observed near a pycnium, in the subepidermal stroma, in hyphae between palisade cells, in the mycelium of the spongy mesophyll and above the aecium. Rarely a cell fusion can be seen between hyphal cells at some distance from an aecium. Cell fusions are most frequently found at or near the upper edge of the aecium, several cells above the sporogenous layer. In the majority of cases several cell divisions take place between the initial binucleate cell of a series and the basal cell which will produce the spores. Basal cells and spores are usually binucleate, rarely tri- or quadri-nucleate.

Ruth F. Allen
Bureau of Plant Industry,
U. S. Department of Agriculture, and
California Agricultural
Experiment Station,
Berkeley, California

BOOKS RECEIVED

Houstoun, R. A. *Intermediate Physics.* Pp. xviii + 638. 588 diagrams. Longmans, Green. $4.20.

Jeans, Sir James. *The Mysterious Universe.* Pp. viii + 163. Illustrated. Macmillan. $2.25.

Kingsley, Nathan H., and Edward J. Menge. *Laboratory Studies, Demonstrations, and Problems in Biology.* Pp. 208. Bruce. $1.28.

Rockefeller Foundation, Annual Report, 1929. Pp. viii + 402. Rockefeller Foundation.

Washington, Henry S. *The Chemical Analysis of Rocks.* Fourth edition, revised. Pp. xvi + 296. Wiley. $4.00.

SPECIAL ISSUE CONTAINING THE PRELIMINARY ANNOUNCEMENT OF THE FOURTH CLEVELAND MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND ASSOCIATED SOCIETIES, DECEMBER 29, 1930, TO JANUARY 3, 1931. EDITED BY BURTON E. LIVINGSTON, PERMANENT SECRETARY.

SCIENCE

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

PRELIMINARY ANNOUNCEMENT OF THE FOURTH CLEVELAND MEETING

Edited by Professor BURTON E. LIVINGSTON
PERMANENT SECRETARY

THE fifteen sections of the American Association together with about forty independent societies will hold scientific sessions at Cleveland in convocation week. This will be the fourth time the association has met in Cleveland. Earlier Cleveland meetings were in July, 1853 (when the association was only five years old); in August, 1888, and in convocation week of 1912–13. Many persons will remember the third Cleveland meeting, which was very successful. Western Reserve University, the Case School of Applied Science and the Cleveland Chamber of Commerce have united in preparations for the meeting this year and arrangements for an unusually large and interesting meeting are nearing completion. Much of the extra cost of the meeting is to be met from a locally raised fund, which has been guaranteed up to $7,500. From registration fees and other current funds the association will probably expend $6,000 or more in connection with this meeting.

The sessions for the natural and exact sciences are to be held mainly in the rooms of Western Reserve University and the Case School of Applied Science. These institutions are adjacent to each other and about four miles from the hotel district, with con-

venient and very efficient transportation. The societies dealing with social and economic sciences will hold their sessions in the hotels. These societies have preferred to make their own local arrangements and they will operate their own registration office. The American Association has arranged with the railway organizations for reduced railway rates, as usual. Any one may take advantage of these rates by securing a certificate for the A. A. A. S. meeting when purchasing his ticket to Cleveland. It is to be noted, however, that these association certificates may be validated only through the association's own registration office, which will be located in the gymnasium building, Western Reserve University. The office will open on Monday morning, December 29, at 9 o'clock and will remain in operation throughout the week; hours from 9 to 6.

This fourth Cleveland meeting will be the eighty-seventh meeting of the American Association and the annual meeting for the association year 1930–31, which began October first. All who are interested in the advancement of science and education are cordially invited to be present through the entire week of the meeting. All the scientific sessions are to be freely open to every one. The general program, published under the auspices of the association, will be available at the association's registration office at 9 o'clock on Monday and throughout the week. The book will be supplied free to all who register and may be purchased by others. Any person who does not attend the meeting may have a free copy of the program sent by mail if a request is addressed to the permanent secretary's office, Smithsonian Institution Building, Washington, D. C. Requests should be received before December 20.

General reports of this meeting are to appear in SCIENCE about February 1. A free copy of the reports may be secured if a request therefor is received by the permanent secretary before January 20. All who regularly receive SCIENCE will receive the reports without any special request.

The fourth Cleveland meeting of the American Association will be held under the presidency of Dr. Thomas Hunt Morgan, of the California Institute of Technology, eminent leader in zoological research. The retiring president this year is Dr. Robert A. Millikan, of the California Institute of Technology. Dr. Millikan is well known, not only for his eminently productive researches in physical science but also for his educational work and for his non-technical writings on the relation of science to human life. He will deliver the main lecture of the meeting at the opening session on Monday evening, December 29, in the Cleveland music hall, on "Atomic Disintegration and Atomic Synthesis."

The Sigma Xi lecture will be given at a general session on Tuesday evening, in the John Hay High School, the lecturer being Dr. C. E. K. Mees, of the Eastman Kodak Company. Dr. Mees's topic is announced as "The Science of Photography." The annual Josiah Willard Gibbs lecture, arranged by the American Mathematical Society, will be given at a general session on Tuesday afternoon by Dr. Edwin B. Wilson, of Harvard University. Dr. Wilson will speak on memories of Professor Gibbs and his work.

A general session is being planned on the various aspects of aquiculture, the growing of plants and animals in water. The Committee of One Hundred on Scientific Research is planning to hold a session on Tuesday at 2:30 in the Statler Hotel. Reports will be presented from some of the subcommittees, and plans for the future of the Committee of One-Hundred will be discussed. There will be evening general sessions on Wednesday and Thursday and several general sessions in the late afternoons. The Cleveland reception will be held on Monday evening, following the opening session.

The regular exhibition of apparatus, books and products useful in science teaching or in research will be unusually interesting this year. It will be housed in the gymnasium of Western Reserve University, along with the registration offices. There will be many exhibits of research methods and achievements of research as well as those placed by manufacturers and supply houses. This is the first time in recent years when special attention is being given to research exhibits and a new level of effectiveness is thus being introduced.

IMPORTANT NOTICES FOR THOSE PLANNING TO ATTEND THE FOURTH CLEVELAND MEETING

Those who plan to attend this meeting should engage hotel rooms at once, addressing the hotels. Whether the room desired is to be occupied by one or two persons should be stated, also the approximate price which the applicant wishes to pay and the date on which the room is to be occupied. If the sort of room requested is not available for the given date the hotel management will refer the request to the Cleveland Convention Board, which will tentatively assign a suitable room in another hotel, informing the applicant by letter. If the applicant does not wish to accept the assignment thus given he should inform the convention board, which will do its utmost to comply with his wishes.

All who are to present papers at this meeting should immediately send two copies of each paper to Mr. Austin H. Clark, director of the press service of the American Association, addressing them in the care of the permanent secretary's office in Washing-

ton. It is well to send a third copy to the section or society secretary in whose program the paper is to be presented. If the full manuscript can not be sent to Mr. Clark, be sure to send him two copies of an abstract.

When purchasing your railway ticket to Cleveland be sure to secure a certificate *for the Cleveland meeting of the American Association for the Advancement of Science,* and bring the certificate with you to the registration offices for the meeting.

LOCAL COMMITTEES AND SECTION REPRESENTATIVES

The general local committee for the Cleveland meeting has the following personnel. Most of the members are chairmen of special committees, as indicated.

Honorary Chairman, Robert E. Vinson, president of Western Reserve University.

Honorary Vice-chairman, William E. Wickenden, president of the Case School of Applied Science.

General Chairman, Harry W. Mountcastle, Western Reserve University.

Chairman of the Special Committee on Finance, Sidney S. Wilson, Western Reserve University.

Chairman of the Special Committee on Hotels, Transportation, Registration and Signs, Winfred G. Leutner, Western Reserve University.

Chairman of the Special Committee on Meeting Places, Harry W. Mountcastle, Western Reserve University.

Chairman of the Special Committee on Equipment, Theodore M. Focke, Case School of Applied Science.

Chairman of the Special Committee on Luncheons and Dinners, J. Paul Visscher, Western Reserve University.

Chairman of the Special Committee on General Sessions and Public Lectures, Dayton C. Miller, Case School of Applied Science.

Chairman of the Special Committee on Exhibitions, Henry B. Dates, Case School of Applied Science.

Chairman of the Special Committee on General Reception and Entertainment, Howard T. Karsner, Western Reserve University.

Chairman of the Special Committee on Press Relations, Charles F. Chapman, Case School of Applied Science.

The local representatives of the several association sections, who cooperate with the local committee in making arrangements for the society and section sessions, are named below.

Local Representatives for Sections

Section A (Mathematics), W. G. Simon, Western Reserve University.

Section B (Physics), D. C. Miller, Case School of Applied Science.

Section C (Chemistry), H. P. Lankelma, Western Reserve University.

Section D (Astronomy), J. J. Nassau, Case School of Applied Science.

Section E (Geology and Geography), J. E. Hyde, Western Reserve University.

Section F (Zoological Sciences), J. P. Visscher, Western Reserve University.

Section G (Botanical Sciences), F. J. Bacon, Western Reserve University.

Societies related to both Zoological and Botanical Sciences, A. H. Hersh, Western Reserve University.

Section H (Anthropology), T. Wingate Todd, Western Reserve University.

Section I (Psychology), H. Austin Aikins, Western Reserve University.

Section K (Social and Economic Sciences), Frank T. Carlton, Case School of Applied Science.

Section L (Historical and Philological Sciences), B. P. Bourland, Western Reserve University.

Section M (Engineering), F. H. Vose, Case School of Applied Science.

Section N (Medical Sciences), H. T. Karsner, Western Reserve University.

Section O (Agriculture), F. J. Bacon, Western Reserve University.

Section Q (Education), C. W. Hunt, Western Reserve University.

Societies related to the A. A. A. S. in general, T. M. Focke, Case School of Applied Science.

GENERAL OFFICERS OF THE ASSOCIATION AND COMMITTEES FOR 1930

President

Thomas Hunt Morgan, California Institute of Technology, Pasadena, Calif.

Retiring President

Robert A. Millikan, California Institute of Technology, Pasadena, Calif.

Vice-presidents, Retiring Vice-presidents and Secretaries of the Sections

Section A (Mathematics):

Vice-president, Gilbert Ames Bliss, University of Chicago, Chicago, Ill.

Retiring Vice-president, E. T. Bell, California Institute of Technology, Pasadena, Calif.

Secretary, Charles N. Moore, University of Cincinnati, Cincinnati, Ohio.

Section B (Physics):

Vice-president, F. K. Richtmyer, Cornell University, Ithaca, N. Y.

Retiring Vice-president, Charles E. Mendenhall, University of Wisconsin, Madison, Wis.

Secretary, A. L. Hughes, Washington University, St. Louis, Mo.

Section C (Chemistry):

Vice-president, James F. Norris, Massachusetts Institute of Technology, Cambridge, Mass.

Retiring Vice-president, Samuel Colville Lind, University of Minnesota, Minneapolis, Minn.

Secretary, R. R. Renshaw, New York University, New York, N. Y.

Section D (Astronomy):
Vice-president, D. W. Morehouse, Drake University, Des Moines, Iowa.
Retiring Vice-president, Harlow Shapley, Harvard University, Cambridge, Mass.
Secretary, Philip Fox, Adler Planetarium and Astronomical Museum, Chicago, Ill.

Section E (Geology and Geography):
Vice-president, Edson S. Bastin, University of Chicago, Chicago, Ill.
Retiring Vice-president, George Frederick Kay, University of Iowa, Iowa City, Iowa.
Secretary, Kirtley F. Mather, Harvard University, Cambridge, Mass.

Section F (Zoological Sciences):
Vice-president, William Albert Riley, University of Minnesota, Minneapolis, Minn.
Retiring Vice-president, Charles Manning Child, University of Chicago, Chicago, Ill.
Secretary, Geo. T. Hargitt, Duke University, Durham, N. C.

Section G (Botanical Sciences):
Vice-president, E. J. Kraus, University of Chicago, Chicago, Ill.
Retiring Vice-president, J. Arthur Harris, *deceased.*
Secretary, Sam F. Trelease, Columbia University, New York, N. Y.

Section H (Anthropology):
Vice-president, Carl E. Guthe, University of Michigan, Ann Arbor, Mich.
Retiring Vice-president, A. V. Kidder, Phillips Academy, Andover, Mass.
Secretary, Charles H. Danforth, Stanford University, Stanford University, Calif.

Section I (Psychology):
Vice-president, Edwin G. Boring, Harvard University, Cambridge, Mass.
Retiring Vice-president, Madison Bentley, Cornell University, Ithaca, N. Y.
Secretary, John E. Anderson, University of Minnesota, Minneapolis, Minn.

Section K (Social and Economic Sciences):
Vice-president, Leonard P. Ayres, Cleveland Trust Co., Cleveland, Ohio.
Retiring Vice-president, Henry Lewis Rietz, University of Iowa, Iowa City, Iowa.
Secretary, Charles F. Roos, Cornell University, Ithaca, N. Y.

Section L (Historical and Philological Sciences):
Vice-president, no election.
Retiring Vice-president, Henry Osborn Taylor, 135 East 66th St., New York, N. Y.
Secretary of the Committee on History of Science, Joseph Mayer, 26 Jackson Place, Washington, D. C.
Secretary of the Committee on Linguistics, Leonard Bloomfield, University of Chicago, Chicago, Ill.

Section M (Engineering):
Vice-president, Frank Baldwin Jewett, 195 Broadway, New York, N. Y.
Retiring Vice-president, H. F. Moore, University of Illinois, Urbana, Ill.
Secretary, N. H. Heck, U. S. Coast and Geodetic Survey, Washington, D. C.

Section N (Medical Sciences):
Vice-president, Louis B. Wilson, Mayo Foundation, Rochester, Minn.
Retiring Vice-president, Ludvig Hektoen, University of Chicago, Chicago, Ill.
Secretary, Charles W. M. Poynter, College of Medicine, University of Nebraska, Omaha, Nebraska.

Section O (Agriculture):
Vice-president, Walter Castella Coffey, University Farm, St. Paul, Minn.
Retiring Vice-president, Merritt F. Miller, University of Missouri, Columbia, Mo.
Secretary, P. E. Brown, Iowa State College, Ames, Iowa.

Section Q (Education):
Vice-president, Leonard V. Koos, University of Chicago, Chicago, Ill.
Retiring Vice-president, Frank N. Freeman, University of Chicago, Chicago, Ill.
Secretary, Willis L. Uhl, University of Washington, Seattle, Wash.

Permanent Secretary

Burton E. Livingston, Johns Hopkins University, Baltimore, Md. (Association mail address: Smithsonian Institution Building, Washington, D. C.)

General Secretary

Frank R. Lillie, University of Chicago, Chicago, Ill.

Treasurer

John L. Wirt, Carnegie Institution of Washington, Washington, D. C.

Secretary of the Council and Program Editor

Sam F. Trelease, Columbia University, New York, N. Y.

Executive Assistant

Sam Woodley, Smithsonian Institution Building, Washington, D. C.

Auditor

A. G. McCall, U. S. Department of Agriculture, Washington, D. C.

Director of the Press Service

Austin H. Clark, U. S. National Museum, Washington, D. C.

The Council of the Association

The council consists of: (1) the president, the general secretary, the permanent secretary and the treasurer; (2) the members of the executive committee not otherwise members of the council; (3) the chairmen of the sections; (4) the section secretaries; (5) the representatives of the affiliated organizations, and (6) eight elected members. The elected members of the council are as follows, the number shown in parentheses being that of the calendar year at the end of which the member's term of office is to expire.

John C. Merriam (1933), Carnegie Institution of Washington, Washington, D. C.

Rodney H. True (1933), University of Pennsylvania, Philadelphia, Pa.

L. O. Howard (1932), U. S. Department of Agriculture, Washington, D. C.

D. T. MacDougal (1932), Desert Laboratory, Tucson, Ariz.

Austin H. Clark (1931), U. S. National Museum, Washington, D. C.

Arthur H. Compton (1931), University of Chicago, Chicago, Ill.

L. E. Dickson (1930), University of Chicago, Chicago, Ill.

David White (1930), U. S. Geological Survey, Washington, D. C.

Members of the Executive Committee of the Council[1]

J. McKeen Cattell (1930), *chairman;* Garrison-on-Hudson, N. Y.

Karl T. Compton (1933), Massachusetts Institute of Technology, Cambridge, Mass.

David R. Curtiss (1931), Northwestern University, Evanston, Ill.

Joel H. Hildebrand (1931), University of California, Berkeley, Calif.

Vernon Kellogg (1932), National Research Council, Washington, D. C.

Frank R. Lillie (1932), *general secretary;* University of Chicago, Chicago, Ill.

Burton E. Livingston (1932), *permanent secretary;* Johns Hopkins University, Baltimore, Md.

Robert A. Millikan (1933), California Institute of Technology, Pasadena, Calif.

Thomas Hunt Morgan (1930), *president of the association;* California Institute of Technology, Pasadena, Calif.

Henry B. Ward (1930), University of Illinois, Urbana, Ill.

Edwin B. Wilson (1932), Harvard School of Public Health, Boston, Mass.

Members of the Committee on Grants for Research[2]

Arthur H. Compton (1933), *chairman of the committee,* for Physics; University of Chicago, Chicago, Ill.

George H. Parker (1933), for Zoology; Harvard University, Cambridge, Mass.

Charles P. Berkey (1932), for Geology; Columbia University, New York, N. Y.

William Charles White (1932), for Medicine; Hygienic Laboratory, U. S. Public Health Service, Washington, D. C.

Walter S. Adams (1931), for Astronomy; Mount Wilson Observatory, Pasadena, Calif.

Karl F. Kellerman (1931), for Botany; U. S. Department of Agriculture, Washington, D. C.

W. Lash Miller (1930), for Chemistry; University of Toronto, Toronto, Ont., Canada.

[1] The number in parentheses denotes the calendar year at the end of which the member's term of office is to expire.

[2] The number in parentheses denotes the year at the end of which the member's term of office is to expire.

Oswald Veblen (1930), for Mathematics; Princeton University, Princeton, N. J.

Members of the Finance Committee

George K. Burgess (1932), *chairman of the committee;* U. S. Bureau of Standards, Washington, D. C.

Arthur L. Day (1931), Geophysical Laboratory, Carnegie Institution of Washington, Washington, D. C.

A. S. Frissell (1933), 530 Fifth Avenue, New York, N. Y.

Herbert Gill (1930), Bethesda, Md.

John L. Wirt (1932), *treasurer of the association;* Carnegie Institution of Washington, Washington, D. C.

The Standing Committee of One Hundred on Scientific Research

Chairman, Thomas Hunt Morgan, president of the American Association; California Institute of Technology, Pasadena, Calif.

Secretary, Rodney H. True, University of Pennsylvania, Philadelphia, Pa.

The Secretaries' Conference

Chairman, Philip Fox, Adler Planetarium and Astronomical Museum, Chicago, Ill.

Secretary, H. J. Van Cleave, University of Illinois, Urbana, Ill.

The Academy Conference

Chairman, D. W. Morehouse, Drake University, Des Moines, Iowa.

Secretary, Chancey Juday, University of Wisconsin, Madison, Wis.

The Committee on the Place of Science in Education

Chairman, Otis W. Caldwell, Columbia University, New York, N. Y.

The Committee on Source Books in the History of Science

Chairman, Gregory D. Walcott, Long Island University, Brooklyn, N. Y.

The Committee on Popular Science Booklists

Chairman, Joseph L. Wheeler, Enoch Pratt Free Library, Baltimore, Md.

The Committee on Exhibition

H. E. Howe, *chairman,* Editor, *Journal of Industrial and Engineering Chemistry.*

C. E. K. Mees, Eastman Kodak Co., Rochester, N. Y.

L. M. Potter, Spencer Lens Company, Buffalo, N. Y.

M. E. Leeds, Leeds and Northrup Company, Philadelphia, Pa.

J. Edward Patterson, Arthur H. Thomas Company, Philadelphia, Pa.

Edward Weston, Weston Electrical Instrument Corp., Newark, N. J.

Thomas H. Morgan, *president of the association,* California Institute of Technology, Pasadena, Calif.

Burton E. Livingston, *permanent secretary of the association,* Smithsonian Institution Building, Washington, D. C.

H. S. Kimberly, *manager of the exhibition,* Smithsonian Institution Building, Washington, D. C.

The Committee on Research Exhibits

F. C. Brown, *chairman;* Museums of the Peaceful Arts, New York.

Owen Cattell, *secretary;* The Science Press, Grand Central Terminal, New York, N. Y.

William Crocker, Boyce Thompson Institute for Plant Research, Yonkers, N. Y.

F. M. Delano, New York Electrical Society, 29 West 39th Street, New York, N. Y.

H. E. Howe, Editor, *Journal of Industrial and Engineering Chemistry,* Washington, D. C.

Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

William A. Riley, University of Minnesota, Minneapolis, Minn.

ORGANIZATIONS THAT ARE TO HOLD SESSIONS AT CLEVELAND, WITH DATES OF THEIR SESSIONS AND OTHER INFORMATION

Note.—Names of organizations are arranged in the order of association sections. Each affiliated society has one or two representatives in the association council, as indicated by one or two asterisks before the society name. A cross before a name indicates that the society is associated but not affiliated. The president and secretary are named for each society, and the council representatives for the affiliated societies. Officers of the sections of the association have been named in an earlier part of this announcement. Dates of meetings are to be read as inclusive. Hotel headquarters and meeting places are generally shown but in a few instances some data are omitted because of lack of information.

A. Mathematics.

** American Mathematical Society. December 29, 30 and 31. Headquarters, Hotel Statler; meeting places, Auditorium and Rooms 216, 219 and 312, School of Education, Western Reserve University. *President,* E. R. Hedrick; *secretary,* R. G. D. Richardson, Brown University, Providence, R. I.; *council representatives,* T. H. Hildebrandt and Louis Ingold.

** Mathematical Association of America. January 1. Headquarters, Hotel Statler; meeting place, Auditorium, School of Education, Western Reserve University. *President,* J. W. Young; *secretary,* W. D. Cairns, Oberlin College, Oberlin, Ohio; *council representatives,* W. D. Cairns and Dunham Jackson.

B. Physics.

** American Physical Society. December 30 and 31. Headquarters, Hotel Statler; meeting place, lecture room, Physics Building, Western Reserve University, and Room 86, Physics Building, and Room 105, Chemistry Building, Case School of Applied Science. *President,* Henry G. Gale; *secretary,* W. L. Severinghaus, Columbia University, New York, N. Y.; *council representatives,* Dayton C. Miller and G. W. Stewart.

* American Meteorological Society. December 29 and 30. Headquarters, Hotel Statler; meeting place, Room 206, Mining Building, Case School of Applied Science. *President,* John Patterson; *secretary,* Charles F. Brooks, Clark University, Worcester, Mass.; *council representative,* W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.

C. Chemistry.

Section C. December 30. Headquarters, Hotel Winton; meeting place, Room 23, Chemistry Building, Western Reserve University.

D. Astronomy.

Section D. December 30 and 31. Headquarters, Hotel Statler; meeting place, Room 69, Main Building, Case School of Applied Science.

E. Geology and Geography.

Section E. December 31 and January 1 and 2. Headquarters, Hotel Winton; meeting place, Room 206, Mining Building, Case School of Applied Science.

F. Zoological Sciences.

** American Society of Zoologists. December 30 and 31 and January 1. Headquarters, Hotel Hollenden; meeting place, John Hay High School. *President,* H. V. Neal; *secretary,* Dwight E. Minnich, University of Minnesota, Minneapolis, Minn.; *council representatives,* H. H. Newman and P. W. Whiting.

** Entomological Society of America. December 30 and 31. Headquarters, Hotel Hollenden; meeting place, Room 10, Mechanical Building, Case School of Applied Science. *President,* Edith M. Patch; *secretary,* J. J. Davis, Purdue University, Lafayette, Ind.; *council representatives,* A. L. Melander and W. A. Riley.

** American Association of Economic Entomologists. December 29 to January 3. Headquarters, Hotel Hollenden; meeting place, Room 24, Electricity Building, Case School of Applied Science. *President,* Franklin Sherman; *secretary,* Albert F. Burgess, 964 Main St., Melrose Highlands, Mass.; *council representatives,* W. E. Hinds and M. H. Swenk.

** American Society of Parasitologists. December 29, 30 and 31 and January 1. Headquarters, Hotel Hollenden; meeting place, Amphitheater, Institute of Pathology, Western Reserve University. *President,* W. W. Cort; *secretary,* N. R. Stoll, Rockefeller Institute for Medical Research, Princeton, N. J.; *council representatives,* Franklin D. Barker and Henry B. Ward.

† Wilson Ornithological Club. December 29 and 30. Headquarters, Hotel Hollenden; meeting place, Room 32, Clark Hall, College for Women, Western Reserve University. *President,* J. W. Stack; *secretary,* Jesse M. Shaver, George Peabody College for Teachers, Nashville, Tenn.

G. Botanical Sciences.

** Botanical Society of America. December 30 and 31 and January 1. Headquarters, Hotel Hollenden; meeting place, Geology Building, Western Reserve University. *President,* Lester W. Sharp; *secretary,* Arthur J. Eames, Cornell University, Ithaca, N. Y.; *council representatives,* Margaret C. Ferguson and I. F. Lewis.

** American Phytopathological Society. December 30 and 31 and January 1. Headquarters, Hotel Hollenden; meeting places, Tuesday morning, December 30, Auditorium, Medical Library Building; Tuesday afternoon, December 30, Room 35, Main Building, Western Reserve

University; Wednesday afternoon, Rooms 34, 35, and 37, Main Building, Western Reserve University; Thursday morning, Rooms 34 and 35, Main Building, Western Reserve University, and Auditorium, Medical Library Building; Thursday afternoon, Rooms 34, 35, and 37, Main Building, Western Reserve University. *President*, H. S. Fawcett; *secretary*, F. C. Meier, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.; *council representatives*, C. W. Edgerton and Donald Reddick.

** American Society of Plant Physiologists. December 29, 30 and 31 and January 1. Headquarters, Hotel Hollenden; meeting place, Freshman Classroom, Law School, Western Reserve University. *President*, H. R. Kraybill; *secretary*, W. A. Gardner, Alabama Polytechnic Institute, Auburn, Ala.; *council representatives*, Charles A. Shull and P. D. Strausbaugh.

F–G. Societies related to both Section F and Section G.

** American Society of Naturalists. Headquarters, Hotel Hollenden; meeting place, Auditorium, Medical Library Building. *President*, A. F. Blakeslee; *secretary*, L. J. Cole, University of Wisconsin, Madison, Wis.; *council representatives*, Herbert Kendall Hayes and A. Franklin Shull.

** Ecological Society of America. December 30 and 31 and January 1. Headquarters, Hotel Hollenden; meeting place, Room 33, Main Building, Western Reserve University. *President*, J. E. Weaver; *secretary*, A. O. Weese, University of Oklahoma, Norman, Okla.; *council representatives*, W. C. Allee and George P. Burns.

** American Microscopical Society. January 2. Headquarters, Hotel Hollenden; meeting place, Room 205, John Hay High School. *President*, D. H. Wenrich; *secretary*, H. J. Van Cleave, University of Illinois, Urbana, Ill.; *council representatives*, H. J. Van Cleave and D. H. Wenrich.

† Phi Sigma Biological Research Society. December 31 and January 1. Headquarters, Hotel Hollenden; meeting place, Room 6, Main Building, Western Reserve University. *President*, P. B. Sears; *secretary*, A. I. Ortenburger, University of Oklahoma, Norman, Okla.

Genetics Sections, American Society of Zoologists and Botanical Society of America. December 30 to January 3. Meeting place, lecture room and laboratory, Biology Building, Western Reserve University. *Chairman*, L. J. Cole; *secretary*, P. W. Whiting, University of Pittsburgh, Pittsburgh, Pa.

H. Anthropology.

** American Anthropological Association. December 29, 30 and 31. Headquarters, Hotel Winton; meeting place, School of Medicine, Western Reserve University. *President*, A. M. Tozzer; *secretary*, A. Irving Hallowell, University of Pennsylvania, Philadelphia, Pa.; *council representatives*, E. A. Hooton and Aleš Hrdlička.

† American Folk-Lore Society. December 29, 30 and 31. Headquarters, Hotel Winton; meeting place, School of Medicine, Western Reserve University. *President*, Edward Sapir; *secretary*, Gladys A. Reichard, Barnard College, New York, N. Y.

American Association of Physical Anthropologists. December 29, 30 and 31. Headquarters, Hotel Winton; meeting place, School of Medicine, Western Reserve University. *President*, Aleš Hrdlička; *secretary*, Dudley J. Morton, College of Physicians and Surgeons, Columbia University, New York, N. Y.

I. Psychology.

Section I. January 2. Headquarters, Hotel Winton; meeting place, Room 33, Main Building, Western Reserve University.

K. Social and Economic Sciences.

Section K. December 29. Headquarters, Hotel Cleveland.

† American Statistical Association. Headquarters, Hotel Statler. *President*, Malcolm C. Rorty; *secretary*, Willford I. King, 236 Wooster Street, New York, N. Y.

† American Sociological Society. Headquarters, Hotel Hollenden. *President*, William F. Ogburn; *secretary*, Ernest W. Burgess, University of Chicago, Chicago, Ill.

† American Economic Association. Headquarters, Hotel Cleveland. *President*, M. B. Hammond; *secretary*, F. S. Deibler, Northwestern University, Evanston, Ill.

Other societies meeting in Cleveland with the social-science group are named below. Our information concerning their plans is very incomplete at this time.

Meeting at Hotel Statler: American Political Science Association.

Meeting at Hotel Winton: Stable Money Association.

Meeting at Hotel Cleveland: American Association for Labor Legislation, American Association of Teachers of Marketing and Advertising, American Association of University Instructors in Accounting, Farm Economics Association.

† Metric Association. December 29. Headquarters and meeting place, Hotel Statler. *President*, George F. Kunz; *secretary*, Howard Richards, 156 Fifth Avenue, New York, N. Y.

L. Historical and Philological Sciences.

** History of Science Society. December 30 and 31. Headquarters, Hotel Winton; meeting place, Room 27, Main Building, Western Reserve University. *President*, Henry Crew; *secretary*, Frederick E. Brasch, Library of Congress, Washington, D. C.; *council representatives*, F. B. Dains and Joseph Mayer.

M. Engineering.

Section M. December 30 and 31. Headquarters, Hotel Winton; meeting place, Room 12, Electricity Building, Case School of Applied Science.

* Institute of Radio Engineers (Cleveland Section). *President*, Lee de Forest; *secretary*, Harold P. Westman, 33 West 39th St., New York, N. Y.; *chairman of Cleveland section*, D. Schregardus, Ohio Bell Telephone Co., 750 Huron Road, Cleveland, Ohio; *council representative*, J. C. Jensen.

N. Medical Sciences.

Section N. Headquarters, Hotel Hollenden.

American Society of Tropical Medicine. Headquarters, Hotel Hollenden; meeting place, Room 109, Institute of Pathology, Western Reserve University. *Secre-*

tary, E. Peterson, Box 131, Pennsylvania Ave. Station, Washington, D. C.

O. Agriculture.

** American Society of Agronomy. December 29 and 30. Headquarters, Hotel Hollenden; meeting place, lecture room, Biology Building, and Law School, Western Reserve University. *President*, W. P. Kelley; *secretary*, P. E. Brown, Iowa State College, Ames, Iowa; *council representatives*, Jay B. Park and John B. Wentz.

* American Society for Horticultural Science. December 29, 30 and 31. Headquarters, Hotel Hollenden; meeting place, Middle Classroom and Senior Classroom, Law School, Western Reserve University. *President*, A. T. Erwin; *secretary*, H. B. Tukey, New York State Agricultural Experiment Station, Geneva, N. Y.; *council representative*, W. H. Alderman.

† Association of Official Seed Analysts of North America. December 31 and January 1 and 2. Headquarters, Hotel Hollenden; meeting place, Room 29, Main Building, Western Reserve University. *President*, A. L. Stone; *secretary*, F. S. Holmes, College Park, Md.

† Potato Association of America. December 30 and 31. Headquarters, Hotel Hollenden; meeting place, Room 23, Main Building, Western Reserve University. *President*, John Bushnell; *secretary*, H. C. Moore, Michigan State College, East Lansing, Mich.

Geneticists Interested in Agriculture. December 29. Meeting place, lecture room, Biology Building, Western Reserve University. *Secretary*, Fred Griffee, Agricultural Experiment Station, Orono, Maine.

Q. Education.

Section Q. December 29, 30 and 31. Headquarters, Hotel Winton; meeting place, School of Applied Social Science, Western Reserve University, 2069 Adelbert Road.

† Phi Delta Kappa Fraternity. Meets with Section Q. *President*, Shelton Phelps; *secretary*, Paul M. Cook, 1180 East 63rd St., Chicago, Ill.

X. Organizations related to the American Association as a whole.

* American Nature-Study Society. December 30 and 31 and January 1. Headquarters, Hotel Hollenden; meeting place, Room 49, Main Building, Case School of Applied Science. *President*, Bertha Chapman Cady; *secretary*, Ellen Eddy Shaw, Brooklyn Botanic Garden, Brooklyn, N. Y.; *council representatives*, J. Andrew Drushel.

** Society of Sigma Xi. December 30. Meeting place, Room 34, Main Building, Western Reserve University. *President*, George W. Stewart; *secretary*, Edward Ellery, Union College, Schenectady, N. Y.; *council representatives*, Edward Ellery and George W. Stewart.

** American Association of University Professors. December 27 and 29. Headquarters, Hotel Statler; meeting place, Room 27, Main Building, Western Reserve University. *President*, W. B. Munro; *executive secretary*, Joseph Mayer, 26 Jackson Place, Washington, D. C.; *council representatives*, Henry Crew and S. A. Mitchell.

† Gamma Alpha Graduate Scientific Fraternity. December 30. Meeting place, Room 29, Main Building, Western Reserve University: *President*, C. C. Murdock; *secretary*, Rodney W. Babcock, Kansas State Agricultural College, Manhattan, Kans.

Sigma Delta Epsilon Graduate Women's Scientific Fraternity. December 30 and 31. *President*, Helen Jean Brown; *secretary*, Mary Dover, University of Missouri, Columbia, Mo.

THE AMERICAN ASSOCIATION PRESS SERVICE AT THE CLEVELAND MEETING

(*By Austin H. Clark*)

The Press Service of the American Association for the Advancement of Science, which has developed from the earlier news service, furnishes to the public, by means of the press, readable and timely accounts of scientific news. It brings scientific workers and newspaper writers together for their mutual aid and for the dissemination of science news. For the Cleveland meeting releases for the press will be prepared beforehand, from manuscripts and abstracts received from those who are to present papers or give addresses at the meeting. All who are to present papers at Cleveland are asked to send, as soon as possible, duplicate copies of each of their manuscripts, to the A. A. A. S. Press Service (A. A. A. S. P. S.), Smithsonian Institution Building, Washington, D. C. *A single copy will not suffice and both copies are to be sent to the same address.* Each manuscript should bear, at the top of the first page, the name of the organization before which the paper is to be presented, with information as to the date of presentation as nearly as that may be stated.

Whenever a paper for this or any other scientific meeting is being typed it will be advantageous to all concerned, including the public, if several clear carbon copies are made; such manifolding is readily accomplished and results in copies enough so that two can be sent at once to the association. Other copies should be sent to the secretaries of the organization at whose sessions the papers are to be given. The manuscripts sent to the association are not for publication as such. They are used by newspaper writers in the preparation of science news. No news story is released before the date on which the paper is presented at the meeting. The Press Service supplies the representatives of the press with the material received from the authors, the date of release being marked on each sheet. It sometimes furnishes such additional information as may be available and it aids press representatives to secure interviews with authors when such interviews are requested.

All manuscripts for use in connection with the Cleveland meeting should reach the Washington office by December 20. Manuscripts that arrive later may not receive attention. The best science stories are written long before the meeting opens, when the writ-

ers may have time for consultation and study in their preparation. It is best to have manuscripts in the hands of the Press Service before December 1. If full manuscripts can not be sent, then authors of papers and addresses for this meeting should send two copies of an adequate abstract of each paper.

Both manuscripts and abstracts should be written in the simplest possible language, so as to be readily understood by any educated person with no presupposed knowledge of the subject treated. Especially should the broader aspects of the subject be presented and its possible bearing on work in other lines and on thought in general.

Until the date of release all authors' manuscripts are regarded as strictly confidential communications, accessible only to accredited representatives of the press and to the members of the association's committee on prize award. There need be no hesitation about sending accounts of new and unpublished work. Authors may themselves send additional copies to newspaper representatives or to the news-gathering agencies, but articles based on such copies may not always be used under the sponsorship of the American Association's Press Service. In any event, two copies are needed by the Press Service.

The director of the Press Service, Austin H. Clark, is ready at all times to answer questions regarding the work of the service and to aid authors and press writers as far as possible. But it must be remembered that Mr. Clark is apt to be pressed for time in the last ten days before a meeting opens. In that period it is difficult for him to do justice to all communications.

The press is now by far the most important medium for the dissemination of scientific knowledge among the people. It is consequently a duty of science workers to do their part, to the end that their findings and ideas may be clearly set before the public. Prepare readable manuscripts and send them early and in duplicate.

THE AMERICAN ASSOCIATION PRIZE

The eighth annual award of the American Association prize, of one thousand dollars, will be made to the author of a paper presented at the Cleveland meeting. Through the generosity of an anonymous member seven of these prizes have thus far been awarded. The prize is awarded each year to the author of a noteworthy paper presented at the annual meeting. It is not necessary that the author be a member of the association. All papers appearing in the General Program are automatically eligible, excepting invited papers and presidential and vice-presidential addresses, which are not eligible. There is to be no open competition and no submitting of papers for the prize. It is supposed, however, that manuscripts of papers that may possibly be considered by the committee on prize award will all be in the hands of the Press Service, through the arrangements described above. No special action should be taken by authors who hope to be considered in this connection. The secretary in charge of each scientific program will be expected to present one or more nominations for consideration by the committee and the committee is expected to make selection from the nominations thus submitted. Nominations are to be in writing, signed by the secretary who sends them, and they are to be addressed to the committee on award, care of Sam Woodley, *executive assistant,* at the registration offices, or else they may be sent to Mr. Woodley in the Statler Hotel. Secretaries may examine the manuscripts that have been received by the Press Service, which will have offices near the registration desks. In making the award no attempt will be made to select the "best" paper presented, for useful comparisons are not possible in different fields of science; the intention is simply that the prize shall be awarded to the author of some notable contribution presented at Cleveland. Previously published work may be considered when pertinent. The donor of the prize desires to aid younger authors by this means rather than to honor older men. The prize is not to be awarded in the same field of science for two consecutive years. The permanent secretary and the other general officers of the association have nothing at all to do with the award, nor can they be in position to give out any information concerning the nominations until after the award has been officially announced. The proceedings of the committee on prize award are to be strictly confidential.

The rules by which the award will be made and announced have been modified and the announcement of the prize winner will not be made at the close of the meeting, as has been done heretofore. According to action taken by the executive committee at its last spring meeting, the award is to be first announced in connection with the meeting following the one at which the paper appeared on the program, and the subject of the winning paper is to be specially presented in a public lecture at the later meeting. (SCIENCE for June 6, 1930, page 588, paragraph 10.) Further details are to be decided upon by the council.

A list of the names of those to whom the association prize has been awarded is shown below, together with the topics dealt with in the winning papers.

(1) The Cincinnati award, January, 1924. L. E. Dickson, for contributions to the theory of numbers.

(2) The Washington award, January, 1925. Divided equally between Dr. Edwin P. Hubble, for contributions on spiral nebulae, and Dr. L. R. Cleveland, for contributions on the physiology of termites and their intestinal protozoa.
(3) The Kansas City award, January, 1926. Dr. Dayton C. Miller, for contributions on the ether-drift experiment.
(4) The Philadelphia award, January, 1927. Dr. George D. Birkhoff, for mathematical criticism of some physical theories.
(5) The Nashville award, January, 1928. H. J. Muller, for contributions on the influence of X-rays on genes and chromosomes.
(6) The New York award, January, 1929. Oliver Kamm, for contributions on the hormones of the pituitary gland.
(7) The Des Moines award, January, 1930. A. J. Dempster, for contributions on the reflection of protons from a calcite crystal.

TRANSPORTATION TO AND FROM CLEVELAND

Reduced railway rates, by the certificate plan, have been granted for this meeting by the railway passenger associations of the United States and Canada, whose courtesy and public spirit will be greatly appreciated. The round-trip fare for a person attending the meeting is to be one and one half times the regular one-way fare.

Tickets to Cleveland are to be purchased within time limits as follows: December 25 to 31, inclusive, for the following lines: Canadian Eastern lines, Canadian Western lines, Central lines, New England lines, Southeastern lines and Trunk lines. For the Western and Transcontinental lines the inclusive dates are December 22 to 28 from California; December 23 to 29 from Arizona, British Columbia, Nevada, Idaho, Montana, Utah, Washington and Oregon (except *via* California); December 21 to 27 from Oregon (*via* California); December 24 to 30 from New Mexico, Wyoming and Colorado (except Julesburg); December 25 to 31 from Julesburg, Colorado, and from Illinois, Iowa, Kansas, Manitoba, Minnesota, Missouri, Nebraska, northern Michigan, North Dakota, South Dakota and Wisconsin. For the Southwestern lines the inclusive dates are December 24 to 30 from Oklahoma and Texas and December 25 to 31 from Arkansas, Kansas, Louisiana and Missouri; also from Memphis, Tennessee, and Natchez, Mississippi. The following Southwestern lines do not offer the reduced excursion fares: Arkansas and Louisiana-Missouri Railway, Fort Smith and Western Railroad, Graysonia, Nashville and Ashdown Railroad, Kansas, Oklahoma and Gulf Railway, Mississippi River and Bonne Terre Railway and National Railways of Mexico.

Persons residing in the regions of reduced rates (almost all the United States and Canada) should each purchase a first-class, full-fare, one-way, through ticket to Cleveland, being sure to secure a certificate on "Standard Certificate Form," reading for the Cleveland meeting of the "American Association for the Advancement of Science and Associated Societies." A receipt is not required and will not be useful.

Persons residing outside the regions of reduced rates should each purchase a round-trip ticket to the nearest station issuing through tickets to Cleveland and situated within the region of reduced rates. On arrival at that station a one-way ticket to Cleveland and a certificate, as directed in the preceding paragraph, should be secured.

Every one should register immediately upon arrival at Cleveland, at the registration offices for the meeting, in the Gymnasium, Western Reserve University. Be sure to fill in all blanks on the registration card and leave the card at the registration desk, where you will receive a numbered identification card, which will be receipted for the registration fee paid. (See Registration, below.) Then leave your railway certificate at the validation desk, being sure that the identification card (which you keep) is there marked to show that you have deposited a certificate. Your certificate will subsequently be endorsed by the association and then validated by the agent of the transportation companies. Call for it later at the validation desk, where you left it, presenting your identification card.

Unvalidated certificates will not be honored for the purchase of return tickets and unendorsed certificates can not be validated. Registration is therefore necessary in order to have a railway certificate validated. Each person registering is entitled to the validation of his own certificate.

For the return trip, railway agents at Cleveland will honor any properly endorsed and validated certificate if presented at least thirty minutes before the scheduled time of departure of the train for which it is to be used. Each person presenting an endorsed and validated certificate may purchase a continuous-passage, one-way, return ticket for one half of the regular fare, by the same route as that followed on the trip to Cleveland. Certificates may be validated from December 29, 1930, to January 3, 1931. The last date on which return tickets may be purchased is January 7.

Some trouble and delay has been experienced at past meetings in securing sleeping-car accommodations for the trip home. Delay may be avoided if reservations can be made at the railway station immediately upon arrival at Cleveland, before going to hotels or

meeting places or to the registration offices. It is often convenient to give the validated certificate to the porter of your hotel, with proper instructions for purchasing return ticket and sleeping-car accommodations. Arrangements for railway reservations may also be made at a special desk in the registration room.

TRANSPORTATION IN CLEVELAND

To reach the four headquarters hotels from the new Union Passenger Terminal, on the Public Square, visitors may find the following notes helpful.

Hotel Cleveland, under the same roof as the Passenger Terminal.

Hotel Hollenden, across Public Square to Superior Avenue, east on Superior Avenue to East 6th Street.

Hotel Winton, across Public Square to Euclid Avenue, east on Euclid Avenue to East 12th Street.

Hotel Statler, across Public Square to Euclid Avenue, east on Euclid Avenue to East 12th Street.

Most of the other hotels are reached by any eastbound street car marked "Euclid." Ask conductor for directions.

To reach the Western Reserve University and the Case School of Applied Science, eastbound street cars marked "East Cleveland," "Windermere," "Hayden—E. 140th," or "Euclid Village." Leave car at Adelbert Road.

The fare on street cars is eight cents, seven tickets for fifty cents. Taxicab rates are five cents per one third mile.

HOTEL ACCOMMODATIONS

The Hotel Statler is to be general headquarters for the American Association, and the headquarters hotels for many of the special societies are named in the list of societies on an earlier page of this announcement. Requests for room reservations should be sent to the hotels.

Those who plan to attend the Cleveland meeting should engage rooms at once. Whether the room desired is to be occupied by one or by two persons should be specified, also the price which the applicant wishes to pay and the date on which the room is to be occupied. If the sort of room requested is not available for the given date the hotel management will refer the request to the Cleveland Convention Board, which will tentatively assign a suitable room in another hotel, informing the applicant by letter. If the applicant does not wish to accept the assignment thus given he should inform the Convention Board, which will do its best to comply with his wishes. All the rooms in the hotel named as headquarters are equipped with baths and the daily charge for a single room is $3.00 and up. For double rooms the daily charges are: Hotel Cleveland, $5.00 and up; Hotel Hollenden, $6.00 and up; Hotel Statler, $4.50 and up; Hotel Winton, $4.50 and up.

An extensive list of Cleveland hotels has been prepared by the permanent secretary's office, with the assistance of the Cleveland Chamber of Commerce, and a copy of this may be had on request addressed to the American Association for the Advancement of Science, Smithsonian Institution Building, Washington, D. C. The list shows the hotel locations and their daily prices for single and double rooms, with and without bath. Those who desire inexpensive rooms should write at once for a copy of the list. Prices for single rooms generally range from $2.00 or $2.50 upward, for double rooms from $3.00 upward.

REGISTRATION AT THE CLEVELAND MEETING

The registration offices for the meeting will be in the Gymnasium of Western Reserve University, as has been said, and they will be open from 9 to 6 daily throughout the week of the meeting. Registration will be necessary in order to secure the official identification card, the official badge and the general program and in order that railway certificates for the association meeting may be endorsed. All who attend any of the sessions arranged through the A. A. A. S. should register promptly, whether they are members of the association or not, using official registration cards that will be provided.

The registration fee will be two dollars, but life members and paid-up annual members of the American Association for the Advancement of Science may register by paying only one dollar. Associates for this meeting may register without paying any registration fee if they show their associateship cards. Foreign associates may show either their cards or their official invitations, received from the permanent secretary. The registration fees will be applied to meet some of the costs of the meeting.

Annual members who are in arrears for association dues may pay their arrearages at the registration offices before they register or at the same time. They may then register with payment of the reduced registration fee. Non-members may join the association or may become associates for this meeting by making the proper payments, thus securing the advantage of the reduced registration fee.

To register, fill in the blanks on a registration card and present the card at the registration desk, paying the proper registration fee. The registration clerk will keep the card and will return to you a numbered identification card, which will entitle you to the privileges of the meeting, including the official badge and a copy of the general program. If you have a rail-

way certificate for validation, leave it at the validation desk, where your identification card will be marked to show that a certificate has been left. (See above, under "Transportation to and from Cleveland.") Delegates from institutions and organizations, and all personally invited foreign associates are specially requested to register as such, noting on their registration cards their exact status in this particular.

MEMBERSHIP AND ASSOCIATESHIP IN THE ASSOCIATION

All members of the association are asked to secure new members or to send to the permanent secretary's office in Washington before December 15 names and addresses of persons who might be interested in joining the association. This request is effective throughout the year, but it is specially desirable that a large number of new members be enrolled before the opening of the meeting.

Copies of a booklet on "The Organization and Work of the American Association," as well as membership application cards and sample copies of the journals, may be secured at any time from the permanent secretary's office. Membership in the association includes a subscription to the weekly journal SCIENCE, or the *Scientific Monthly*, for the calendar year beginning at the close of the annual meeting. The journal alone is worth more than the annual membership dues. Annual members of the association may have both SCIENCE and the *Scientific Monthly* by paying $3.00 in addition to the annual dues ($8.00 in all), if the additional payment accompanies the remittance of annual dues. Annual members of the association may also subscribe for the *Science News-Letter* at the specially reduced price of $3.00 per year, if the additional remittances accompany their payment of dues in each case. Life members may receive one or both of the extra journals by paying $3.00 for each subscription.

New members of the association regularly pay an entrance fee of $5.00, but this year that fee is remitted to members of any associated organizations, including the affiliated state academies. Those who take advantage of this privilege and join at the Cleveland meeting without paying the entrance fee should fill in the blanks on a blue membership application card and present card and dues for 1930–31 ($5.00) when they register. All who attend the Cleveland meeting are asked to join the American Association when they register, unless they are already enrolled.

Those who are not members of the American Association and who do not wish to join at this time are invited to become associates for this meeting. The associate fee is $5.00. Associates have all the privileges of the meeting, except voting, and they will receive the general reports of the meeting when these are published about February 1. They are to register without paying any registration fee. Associate fees will be used to help defray the costs of the meeting.

FOREIGN ASSOCIATES

Visitors from outside of the United States and Canada who are not members of the association may be invited to the meeting as foreign associates. Members of the association may recommend to the permanent secretary persons who should receive official invitations, giving reasons. Such recommendations should arrive in the permanent secretary's office in Washington before December 20, and the present address, as well as the home address, of the recommended person should be given in each instance. Eligibility to this honor is about the same as eligibility to fellowship in the association.

INFORMATION SERVICE, MAIL, EXPRESS, TELEGRAMS, ETC.

Those in attendance at the Cleveland meeting may obtain information of all sorts by applying at the information desk in the registration offices. Attention is called, however, to the visible directory of those in attendance, from which may be obtained names and both home and Cleveland addresses of those who have registered.

Persons attending the meeting may have mail, etc., addressed to them in care of the American Association for the Advancement of Science, registration office, Gymnasium, Western Reserve University, Cleveland, Ohio. They should inspect the personal bulletin every day, which will be conveniently located in the vicinity of the registration desks. If a person's name appears on this bulletin he should inquire at the proper desk for mail, etc. Uncalled-for telegrams will be sent to hotels each afternoon when the registration offices close, unless the person addressed has failed to register and give his hotel address. Unclaimed mail, etc., will be mailed to home addresses after the close of the meeting.

BUSINESS SESSIONS OF THE AMERICAN ASSOCIATION AT CLEVELAND

The executive committee of the council is to meet at 10 o'clock on Monday, December 29, in the Statler Hotel, and the council is to hold its first Cleveland session at 2 o'clock on the afternoon of the same day, in the council room (Room 3, Main Building, Western Reserve University). This council session is to be followed by the Cleveland session of the Academy Conference. Unless otherwise decided, the council will meet at 9 on Tuesday, Wednesday, Thursday and Friday in the council room, and the executive com-

mittee will meet in the council room at 10 on the same days. The election of association officers for 1931 is to occur at the council session Wednesday or Thursday morning, as the council may decide.

Business to come before the council at Cleveland is to be referred to the executive committee first, and memoranda concerning such business should be in the Washington office by December 20. Communications that arrive late, especially those coming to the permanent secretary after the opening of the meeting, may fail to receive consideration, for the week of the meeting is a very busy one for all officers of the association.

THE SECRETARIES' CONFERENCE AND THE ACADEMY CONFERENCE

The Secretaries' Conference, a special committee of the American Association, plans to hold its annual dinner and session at Cleveland, time and place to be announced later. The secretary of this conference is Dr. Harley J. Van Cleave, secretary of the American Microscopical Society, who has charge of the program. The chairman is Dr. Philip Fox, secretary of Section D. The conference consists of the secretaries of the association sections, the secretaries of the associated societies and the members of the executive committee of the association.

The Academy Conference of the American Association is planning to hold its Cleveland session at the close of the first council session, on Monday afternoon, December 29. This conference consists of the council representatives of the affiliated academies of science and three representatives of the association. The secretary of the conference this year is Dr. Chancey Juday, of the Wisconsin Academy, who has charge of the program. The chairman is Dr. D. W. Morehouse, of the Iowa Academy.

SCIENTIFIC SESSIONS OF SECTIONS AND SOCIETIES AT CLEVELAND

Nearly all fields of science will be represented in the sessions of the sections and their related societies at the eighty-seventh meeting of the American Association. There will be many joint sessions of two or more organizations and many symposia of invited papers on timely topics, as well as a large number of society dinners, luncheons and smokers. A great many sessions will be devoted to the reading of technical contributions. The addresses of the retiring vice-presidents of the association and those of the presidents of the special societies will each be important in indicating the present status and the outlook in each of the several branches of science. It is, of course, impossible to present the numerous programs of the meeting in this announcement, for which the reader must await the appearance of the society programs and the general program. The latter will be printed in the last two weeks before Christmas, edited for the permanent secretary's office by the program editor, Dr. Sam F. Trelease, of Columbia University. As has been said, the general program will be available at 9 o'clock, December 29, at the registration offices for the meeting, in the Gymnasium of Western Reserve University, and copies will be mailed promptly to those who are not going to attend the meeting, if they send in their requests early.

The following pages are devoted to preliminary notes on the special programs of the scientific sessions at Cleveland. These notes have been compiled by the permanent secretary from accounts furnished by the several secretaries of societies and sections, to whom we are greatly indebted for the material presented here. It is, of course, to be remembered that all statements are of a preliminary nature.

These notes on the plans of the many organizations that will take part in the meeting at Cleveland are arranged under headings that correspond to the sections of the American Association. Generally each of the associated and invited societies is related primarily to a single association section, but in some instances the societies can be properly classified only by reference to two sections or to the association as a whole. In connection with these notes see the list of organizations planning to hold sessions at the Cleveland meeting, in an earlier part of this announcement, where the names of the society officers and the dates of the society meetings are shown, as well as their hotel headquarters and most of the places for their meetings.

MATHEMATICS.—On Monday afternoon, December 29, there will be a joint meeting of the American Mathematical Society, the Statistical Association of America and Section A. Professor G. C. Evans, of Rice Institute, will speak on "Simple Types of Economic Crises and Cycles"; Professor Ragnar Frisch, of Yale University, on "A Method of Decomposing an Empirical Series into its Cyclical and Progressive Components"; Professor Harold Hotelling, of Stanford University, on "Recent Improvements in Statistical Inference." On Tuesday afternoon Professor G. D. Birkhoff, of Harvard University, will deliver an address on "Poincaré's Last Geometric Theorem, its Generalizations and Dynamical Applications"; this address is given at the request of the American Mathematical Society. Later, on the same afternoon, the eighth annual Josiah Willard Gibbs lecture, under the auspices of the American Mathematical Society and the American Association, will be delivered by Professor Edwin B. Wilson, of the Harvard School of

Public Health. On Wednesday afternoon there will be a joint meeting of the American Mathematical Society, the Mathematical Association of America and Section A. At this time the retiring vice-president for Section A, Professor E. T. Bell, of the California Institute of Technology, will deliver an address on the subject, "Mathematics and Speculation." A second address, entitled "Recent Developments in Abstract Algebra," will be given by Professor Oystein Ore, of Yale University, at the joint invitation of the American Mathematical Society and the Mathematical Association of America. There will also be sessions of the American Mathematical Society for the presentation of research contributions.

The Mathematical Association of America will hold sessions on Thursday morning and afternoon with a program of invited speakers, among these being Professor B. F. Finkel, of Drury College, on "The Early History of the *American Mathematical Monthly*"; Professor Tibor Rado, of Ohio State University, on "Mathematics in Hungary"; Professor C. F. Roos, of Cornell University, on "Theoretical and Statistical Investigations Concerning the Interrelations of Demands, Cost of Production and Profit"; and Professor J. R. Musselman, of Western Reserve University, on "The Equilateral Hyperbola." An informal dinner for the mathematics group is scheduled for Wednesday evening. A joint meeting of mathematicians and physicists is also projected, but definite arrangements have not yet been made.

PHYSICS.—Section B will hold joint meetings with the American Physical Society and with the American Meteorological Society. The retiring vice-president, Professor C. E. Mendenhall, will give an address on "Recent Developments in Photoelectricity." There will be a symposium on acoustics. The greater part of the program of the joint meetings will consist of the regular papers contributed by members of the two affiliated societies.

CHEMISTRY.—Section C plans to hold a session on Tuesday, December 30, in the Morley Chemical Laboratory, Western Reserve University. The program is being arranged by the Cleveland Section of the American Chemical Society.

ASTRONOMY.—Cleveland offers much of interest to astronomers. The mountings of many of the world's greatest telescopes were designed and built by Warner and Swasey, of Cleveland. This firm has been a pacemaker in instrument construction, combining in their designs facility of operation and precision. The original Michelson and Morley experiments on etherdrift were made in the laboratory of the Case School of Applied Science. Here also Professor D. C. Miller is continuing observations in this fundamental experiment. The Municipal Observatory is a third item to attract the attention of astronomers.

Sessions for the presentation of papers in astronomy will be held in room 69, Main Building, Case School of Applied Science, on Tuesday, at 10 and 2 o'clock. There will be a joint session of Section D with Section L and the History of Science Society, in commemoration of the tricentenary of Johannes Kepler. On Wednesday afternoon Dr. Harlow Shapley, of Harvard University, retiring vice-president for Section D, will give an address on "Galactic Explorations."

GEOLOGY AND GEOGRAPHY.—Section E will hold sessions for the reading of papers on Wednesday, Thursday and Friday. On Thursday afternoon the retiring vice-president for the section, Dean George F. Kay, of the University of Iowa, will deliver an address on "The Classification and Duration of the Pleistocene Period." A dinner for geologists and geographers is being arranged for either Thursday or Friday evening. The scientific sessions will be so arranged as to permit the attendance of those who have been in Toronto earlier in the week for the meeting of the Geological Society of America at that place.

ZOOLOGICAL SCIENCES.—Section F will meet jointly with the American Society of Zoologists on Tuesday, Wednesday and Thursday. The section will not hold sessions of its own for the reading of papers, but a short business meeting will be held on one afternoon. A dinner for all zoologists will be held on the evening of either Tuesday or Wednesday. Dr. William A. Riley, of the University of Minnesota, the vice-president for the section, will deliver an address immediately following the zoologists' dinner, on "Some Present-day Problems in Zoological Teaching."

The Entomological Society of America will hold its twenty-fifth annual meeting on Tuesday and Wednesday, under the presidency of Dr. Edith M. Patch, of the Maine Agricultural Experiment Station. The Tuesday morning session will be devoted to business and reading of papers. The Tuesday afternoon session will include a symposium entitled, "Forest Entomology," headed by Dr. J. M. Swaine, of Canada. On Tuesday evening the annual public address of the society will be given by Professor H. J. Quayle, of the University of California, on "Observations Abroad on Subtropical Fruit Insects." Wednesday will be devoted to contributions, with a business session in the afternoon. The annual entomologists' dinner will probably be held Thursday evening.

The American Association of Economic Entomologists will hold its forty-third annual meeting from Monday to Friday. A varied and interesting program on many phases of entomological work is being

arranged. The morning and afternoon sessions on Monday will be devoted to the section of apiculture, under the chairmanship of Professor R. L. Parker, of the Kansas Agricultural College. On Tuesday the Section of Quarantine and Inspection, under the chairmanship of Professor E. N. Cory, of the University of Maryland, will hold morning and afternoon sessions. The general meeting will open on Wednesday morning, under the presidency of Professor Franklin Sherman, of Clemson College, who will deliver the annual address. Thursday and Friday will be devoted to scientific sessions. The Section of Extension Entomologists will hold a session on Thursday evening, with Professor C. R. Crosby, of Cornell University, as chairman.

The American Society of Parasitologists will hold its sixth annual meeting on Tuesday, Wednesday and Thursday. Of special interest will be a joint program on Wednesday with the American Society of Tropical Medicine, which is meeting with the association this year for the first time. The fact that frequently a majority of the papers presented at the meetings of either the American Society of Parasitologists or the American Society of Tropical Medicine have a primary interest as well for members of the other organization renders this joint meeting an event of considerable promise. On Tuesday morning there will be held the customary joint session with the American Society of Zoologists. The address of the retiring president, Dr. W. W. Cort, of the Johns Hopkins University, will be on "Recent Investigations on the Epidemiology of Ascariasis." Besides the usual sessions for the presentation of papers, there will be time allotted for demonstrations, as in previous years. The society will hold its annual business session and a luncheon.

The Wilson Ornithological Club will hold its seventeenth annual meeting on Monday and Tuesday, with morning and afternoon sessions. The annual dinner of the club will be held jointly with the Cleveland Bird Club and the Inland Bird-Banding Association.

BOTANICAL SCIENCES.—Section G will hold a joint session with the associated botanical societies on Tuesday afternoon, December 30. The program will include the following papers: "Hybridization and Inheritance in Ascomycetes," by B. O. Dodge; "Some Mycorrhiza Considered from the Viewpoint of Physiology," by Lewis Knudson; "Chromosome Structure and the Mechanism of Crossing-over," by Karl Sax; "Vegetation of the Ohio Valley," by E. N. Transeau.

The Botanical Society of America is to hold its twenty-fifth annual meeting on Tuesday, Wednesday and Thursday. Business sessions are to be held each morning at 9, followed at 10 by scientific sessions of the five sections of the society. In the afternoons, joint sessions will be held with Section G of the American Association, the Ecological Society of America and the American Society of Naturalists. The annual dinner for all botanists will be held on Tuesday evening. At this time Dr. Margaret C. Ferguson, of Wellesley College, will deliver the retiring presidential address. The section programs of this society will be representative of their special fields and all branches of botany will be dealt with in the papers presented.

The American Phytopathological Society will meet Tuesday, Wednesday and Thursday, under the presidency of Dr. H. S. Fawcett, of the Citrus Experiment Station, University of California. A joint session with Section G will be held on Tuesday afternoon and a joint session with the Mycological Section of the Botanical Society of America will occur on Wednesday morning, the latter being devoted to a de Bary Memorial program. There will be a round table discussion Tuesday afternoon on extension work in plant pathology. The program on Tuesday morning will be made up of a series of invitation papers on subjects of general interest, which will be followed by a business session. Sessions on Wednesday afternoon, Thursday morning and Thursday afternoon will be devoted to contributions on diseases of vegetables, cereals, fruits and ornamentals, and to papers on other interesting topics. The annual dinner of the society is to occur on Tuesday; tickets should be secured before Tuesday noon, at the registration offices of the A. A. A. S. or in the lobby of the Hotel Hollenden. A program of great interest to all plant pathologists and botanists will follow the dinner.

The seventh annual meeting of the American Society of Plant Physiologists is to occur from Monday to Thursday. Sessions for the presentation of contributions and the transaction of business will be held on Monday, Wednesday and Thursday. There will be two joint sessions: one with the American Society for Horticultural Science, Tuesday morning, the other with the Botanical Society of America, Tuesday afternoon. The second award of the Stephen Hales Prize will be made at the annual dinner on Monday evening, at the Chamber of Commerce Club. Following the dinner there will be the presidential address, by Dr. H. R. Kraybill, of Purdue University, and an address by Dr. D. R. Hoagland, of the University of California.

BIOLOGICAL PROGRAMS RELATED TO BOTH ZOOLOGY AND BOTANY.—The forthcoming Cleveland convention of the American Society of Naturalists will be its forty-eighth annual meeting. The meeting will consist of two sessions on Thursday. According to recent cus-

tom, the afternoon session will be devoted to a symposium on a subject of general biological interest, held in conjunction with other biological societies. The general subject for this year is "The Future of Man in the Light of His Past." Among the speakers will be Dr. A. V. Kidder (Carnegie Institution) and Dr. E. M. East (Harvard). The report and recommendations of the special committee on policy, appointed at Des Moines last winter, will be presented and discussed, either at a business session following the afternoon symposium or at the annual dinner. The place and time of the dinner are to be announced later. Dinner tickets may be had from Professor J. Paul Visscher, of Western Reserve University, or at the general registration offices of the A. A. A. S.

The Ecological Society of America is to meet on Tuesday, Wednesday and Thursday. Two joint sessions with other organizations are planned, with the American Society of Zoologists on Wednesday morning and with the Botanical Society of America on Wednesday afternoon. Symposia or less formal groups of papers and discussions are planned on the following subjects: "Crop Ecology," in charge of President Weaver; "Plant and Animal Interrelations," in charge of Dr. H. C. Cowles (University of Chicago); "Environmental Units and Their Terminology," in charge of Dr. W. E. Allen (Scripps Institution). Other sessions will be devoted to papers of general ecological interest and to business. There will be an informal dinner.

The American Microscopical Society will hold its annual business meeting and election of officers on Friday afternoon, January 2, at 4 o'clock.

The Phi Sigma Biological Research Society will hold its annual convention and meetings on Wednesday and Thursday. The morning and afternoon sessions of the first day will be taken up with business. The second day will be devoted to the reading of research contributions. A banquet will be held for the delegates.

The Genetics Sections of the American Society of Zoologists and the Botanical Society of America will hold regular sessions for the reading of papers on Tuesday, Wednesday, Thursday and Friday mornings. There will be a short business session for the election of officers and to receive the report of a committee chosen at the Des Moines meeting to study the organization of geneticists. During the afternoons there will be informal laboratory demonstrations and exhibits. The Genetics Sections will meet Monday morning with the Geneticists Interested in Agriculture, in a symposium on "Inbreeding and Its Application to Improvement in Plants and Animals." (See under Agriculture, below.)

ANTHROPOLOGY.—The meetings of Section H will occur on Tuesday and Wednesday. The address of the retiring vice-president for the section will be given by Dr. A. V. Kidder at the anthropologists' dinner, details of which will be announced later. There will be joint sessions with the American Anthropological Association and the American Folk-Lore Society, at which papers of wide interest will be discussed. As is the custom when the various anthropological groups meet with the American Association, the program of Section H will be limited largely to papers and demonstrations relating to physical anthropology. Work in this latter field has been especially fostered at Cleveland and the present meeting promises to be one of unusual interest. The American Association of Physical Anthropologists will also hold sessions at Cleveland this year.

PSYCHOLOGY.—Section I will hold sessions on Friday, January 2. Professor Madison Bentley, of Cornell University, retiring vice-president for the section, will give the vice-presidential address in the afternoon. His title will be "Psychology's Family Relations among the Sciences." The remainder of the sessions will be devoted to contributions.

SOCIAL AND ECONOMIC SCIENCES.—Section K will hold no sessions by itself. A joint session with Section A (Mathematics), the American Mathematical Society and the American Statistical Association will be held Monday afternoon, the program being devoted to mathematical papers on statistics and economics. The invited speakers for this session are Professor G. C. Evans (Rice Institute), Professor Ragnar Frisch (Yale University) and Professor Harold Hotelling (Stanford University). Professor Evans will give a paper entitled "Simple Types of Economic Crises and Cycles," and Professor Hotelling will speak on "Recent Improvements in Statistical Inference." Professor Frisch's subject is to be announced.

Although the permanent secretary has little detailed information concerning the plans of the independent scientific societies of the social-economic group that are to meet in Cleveland in convocation week—since these societies have preferred to manage their own arrangements and their secretaries have consequently not kept the Washington office informed as preparations have proceeded—yet it is certain that the sessions of this group of societies will constitute a very important part of the unusual attractions of the Cleveland meeting. It is very unusual to have the social and economic sciences so strongly represented along with the natural and exact sciences, and the association is highly gratified by the presence of these important societies this year. The council has repeat-

edly expressed the hope that these two main groups of science workers may come into closer contact, for mutual benefit and appreciation and for the advancement of science as a whole.

The Metric Association will hold sessions at the Hotel Statler on Monday morning and afternoon, celebrating the fourteenth anniversary of the founding of the organization. The morning session will be devoted to problems of standardization in industry. There will be the usual Weights and Measures luncheon. The afternoon session will be devoted to legislation, education, publicity and business. The annual Metric dinner, at the Hotel Statler, will occur Monday.

HISTORICAL AND PHILOLOGICAL SCIENCES.—The History of Science Society will hold sessions on Wednesday and Thursday, in conjunction with the committee on the promotion of Chinese studies, of the American Council of Learned Societies. The first day will be devoted to the history of science in China, with papers on ephedrin, alchemy, tropical medicine, horticulture, agriculture, mathematics and the Chinese scientific method. A joint session with Sections D and L will be devoted to papers commemorating the tricentenary of the death of Johannes Kepler. A session is being planned for papers on the development of laboratories in the universities of the Middle Ages.

ENGINEERING.—Section M will hold sessions on Tuesday morning and afternoon and on Wednesday morning. The Tuesday sessions, arranged by a local committee, are to be devoted to recent developments in telephony, mechanics of the telescope, sewage and water problems of the Great Lakes region, and recent metallurgical developments. At the Wednesday session will be presented the retiring vice-presidential address of Professor H. F. Moore, of the University of Illinois, who will speak on "Engineering Culture." The education of engineers after leaving college will be the topic of another address.

The Cleveland section of the Institute of Radio Engineers is planning to hold sessions in convocation week, but further information concerning these important programs has not been received.

MEDICAL SCIENCES.—It is expected that Section N will hold a session of invited papers on medical topics of general interest. The American Society of Tropical Medicine has intimated that it will hold sessions at Cleveland, but definite information is still lacking.

AGRICULTURE.—Section O will hold morning and afternoon sessions on Tuesday, with the American Society of Agronomy, in a symposium on "Nitrogen Relationships in Soils," arranged by Professor R. M. Salter, of Ohio State University. The invitation papers will deal with the several important aspects of the nitrogen problem. A joint dinner with the American Society of Agronomy and other associated societies will be held on Tuesday evening, at which time Professor M. F. Miller, of the University of Missouri, will deliver the address of the retiring vice-president for Section O.

The American Society for Horticultural Science will hold its twenty-seventh annual meeting on Monday, Tuesday and Wednesday. The annual horticulturists' dinner will occur on Tuesday evening, after which the address of the retiring president will be given by A. T. Erwin, of Iowa State College. There will be a joint session with the American Society of Plant Physiologists on Tuesday forenoon. A session will be devoted to floriculture and ornamental horticulture.

The Association of Official Seed Analysts is to meet on Wednesday, Thursday and Friday. The presidential address will be given Wednesday, by President A. L. Stone, of the University of Wisconsin. Thursday will be devoted to a symposium on variations and tolerances, at which the discussion will be led by W. H. Wright, of the Canadian Department of Agriculture. Among the speakers at this symposium will be Edgar Brown (U. S. Department of Agriculture), H. R. Kraybill (Purdue University) and M. T. Munn (New York Agricultural Experiment Station, Geneva). The annual dinner of this association will be held on Thursday evening. There will be the usual business session, with committee reports and a number of papers of general interest.

The Potato Association of America plans to hold sessions on Tuesday and Wednesday, with papers on many phases of potato culture, but the permanent secretary has no further information in this connection.

The Geneticists Interested in Agriculture will meet on Monday morning with the Genetics Sections of the Zoological and Botanical Societies. This session will be devoted to a symposium on "Inbreeding and Its Application to Improvement in Plants and Animals." The speakers will be F. A. Krantz (Universty of Minnesota) and W. F. Dove (University of Maine). Dr. Krantz will consider the subject with particular reference to improvement in potatoes and Dr. Dove from the standpoint of poultry breeding. On Monday afternoon there will be a joint session with the American Society of Agronomy, at which a program on "Inbreeding with Particular Reference to Maize" will be presented. The speakers will be R. J. Garber (West Virginia University) and F. D. Richey (U. S. Bureau of Plant Industry).

EDUCATION.—Six sessions of Section Q are planned for Monday, Tuesday and Wednesday. A joint din-

ner of the section with the Societies of Phi Delta Kappa and Kappa Delta Pi is planned for Tuesday evening. A brief program will follow the dinner, devoted to studies in administrative and supervisory research. At the Tuesday afternoon session the retiring vice-president for Section Q, Dr. Frank N. Freeman (of the University of Chicago), will present an address. The topics for the other sessions are: "Research in Elementary Education," Monday morning; "Research in Secondary and Collegiate Education," Monday afternoon; "Research in Social Studies and other Problems of Character Training," Tuesday morning; "Investigations in the Teaching of Science," Wednesday morning.

PROGRAMS RELATED TO SCIENCE IN GENERAL.—The Society of the Sigma Xi is to hold on Tuesday afternoon a business meeting beginning at 4 o'clock. The annual dinner will occur Tuesday at 6:30 and the ninth annual Sigma Xi lecture will be given at the general session Tuesday evening, by Dr. C. E. Kenneth Mees, director of research of the Eastman Kodak Company. Tickets for the dinner may be secured, before Tuesday noon, at the general registration offices in the gymnasium of Western Reserve University. The American Nature-Study Society plans to hold sessions on nature-study problems of various kinds, especially nature education. A dinner of the society is planned. The Gamma Alpha Scientific Fraternity will hold its council meeting on Tuesday afternoon and a breakfast on Wednesday morning. A proposed revision of the constitution will be considered. Sigma Delta Epsilon, Graduate Women's Scientific Organization, will have two breakfast meetings, with interesting talks. The Tuesday breakfast will be for all women visitors, while the meeting on Wednesday will be specially for members of the organization.

SCIENTIFIC EVENTS

THE BRITISH FRESHWATER BIOLOGICAL STATION

ACCORDING to an article in the London *Times* the Freshwater Biological Association of the British Empire was founded in the early part of this year with the object of securing the establishment of a freshwater laboratory to prosecute research into the problems of freshwater biology. Although the movement originated among the professional biologists of Great Britain, it has secured the support of the leading scientific societies and of a large proportion of the economic bodies interested in river pollution, freshwater fisheries, and the like.

The conference convened by the council of the association at Fishmongers' Hall on February 21 last afforded evidence of the interest displayed and showed that there is a real and widely felt need for a freshwater research station. Promises of financial support in the form of annual grants have been received from many sources. They are conditional upon the actual founding of the station as a research center. The council are now making an appeal for contributions to a fund for the establishment and initial equipment of the station, and several hundred pounds have already been promised.

It is hoped that all who are interested in fresh waters, such as public bodies responsible for water supply, medical officers of health, water and sanitary engineers, fishermen and naturalists, will realize the importance of the projected station and will be prepared to help by contributing to the fund. Contributions of any amount, large or small, will be welcomed.

The council have prepared a pamphlet giving an outline of the aims of freshwater biology in the British Isles, which includes a scheme of work and plans for the projected station. This pamphlet, as well as the report of the conference at Fishmongers' Hall, can be obtained on application to the acting secretary, Professor F. Balfour Browne, Winscombe Court, Winscombe, Somerset.

CELEBRATION OF THE TWENTY-FIFTH ANNIVERSARY OF THE THEORY OF RELATIVITY

ON November 10, the University of Colorado celebrated the twenty-fifth anniversary of the theory of relativity. It was on September 26, 1905, that Professor Einstein's first paper on relativity entitled, "Zur Elektrodynamik Bewegter Körper," appeared in the *Annalen der Physik*. As far as is known, this was the second celebration honoring the famous physicist, the first being that of the Royal Society in London some time ago.

The celebration opened with a banquet in the Memorial Union Building with places set for one hundred and seventy persons, consisting of students, faculty, townspeople and delegations from the Colorado School of Mines, Colorado State Teachers' College and the Colorado Agricultural College. At the dinner Dr. Junius F. Brown, of the department of psychology, gave reminiscences of Professor Einstein as he knew him in the seminar in Berlin last year.

After the dinner addresses were given by various members of the faculty. Dean O. C. Lester, of the Graduate School, spoke on "The Changed Outlook on

Physical Theories"; Dr. V. P. Lubovich, assistant professor of physics, spoke on "Does the Inertia of a Body Depend upon its Energy Content?"; Dr. Walter B. Veazie, of the department of philosophy, discussed "Relativity and Philosophy," and Dr. Frank E. E. Germann, professor of chemistry, spoke on "Chemistry and Relativity."

During the program, a painting of Dr. Einstein by Miss Virginia True, of the art department, was unveiled. An informal hour followed in the banquet room, where fifteen posters hanging on the walls representing "practical" applications of Einstein's theory of relativity were studied. A letter of congratulation, signed by those at the dinner, was sent to Professor Einstein.

FRANK E. E. GERMANN

JOINT MEETING AT LOS ANGELES OF THE AMERICAN PHYSICAL SOCIETY AND OF THE ACOUSTICAL SOCIETY OF AMERICA

A JOINT meeting of the American Physical Society and the Acoustical Society of America will be held on the campus of the University of California at Los Angeles on December 12 and 13. Dr. Vern O. Knudsen, associate professor of physics, is in charge of arrangements for the meeting. More than two hundred delegates from various parts of America are expected to attend.

According to preliminary plans, there will be one joint session of the two organizations. At this session it is planned that six papers will be presented, including three papers by members of each association. In addition there will be a symposium on the recording and reproducing of sound in talking moving pictures, and also a symposium on atmosphere acoustics and sound signaling. An inspection tour of the talking-picture studios is also planned for the visitors.

Professor Leonard B. Loeb, of the University of California, Pacific Coast secretary of the American Physical Society, is in charge of the arrangements for his organization. Other officers of this society include Dr. Henry G. Gale, University of Chicago, *president;* Dr. W. F. G. Swann, Bartol Research Foundation, Philadelphia, *vice-president;* Dr. W. L. Severinghaus, Columbia University, *secretary;* Dr. G. B. Pegram, Columbia University, *treasurer,* and Dr. John A. Tate, of the University of Minnesota.

Officers of the Acoustical Society of America include Dr. Harvey Fletcher, of the Bell Telephone Laboratory of New York, *president;* Dr. Vern O. Knudsen, of the University of California at Los Angeles, *vice-president;* Wallace Waterfall, of Chicago, *secretary,* and Dr. E. E. Free, of New York, *treasurer.*

SCIENTIFIC NOTES AND NEWS

THE awards of royal and other medals by the Royal Society, London, have been announced as follows: A Royal Medal to Professor O. W. Richardson, F.R.S., for his work on thermionics and spectroscopy. A Royal Medal to Professor J. E. Marr, F.R.S., for his pioneer work in the accurate zoning of the Paleozoic rocks. The Copley Medal to Sir William Bragg, K.B.E., F.R.S., for his contributions to crystallography and radioactivity. The Rumford Medal to Professor Peter Debye, of Leipzig, for his work relating to specific heats and X-ray spectroscopy. The Davy Medal to Professor R. Robinson, F.R.S., for his work on the constitution and synthesis of natural products, and for his contributions to the theory of original reactions. The Darwin Medal to Professor Johannes Schmidt, of Copenhagen, for his extended oceanographical expeditions and his genetic studies on animals and plants. The Hughes Medal to Sir C. V. Raman, F.R.S., of Calcutta, for his work on the abnormal scattering of light. The following is a list of those recommended by the president and council for election at the anniversary meeting on December 1: Sir F. Gowland Hopkins, *president;* Sir Henry Lyons, *treasurer;* Dr. H. H. Dale and Dr. F. E. Smith, *secretaries;* Lord Rayleigh, *foreign secretary.* Other members of the council: Professor E. V. Appleton, Professor G. Barger, Professor A. E. Boycott, Professor E. P. Cathcart, Sir Alfred Ewing, Professor E. S. Goodrich, Professor G. H. Hardy, Sir Harold Hartley, Sir Thomas Lewis, Dr. W. H. Mills, Professor E. A. Milne, Dr. A. B. Rendle, Professor R. V. Southwell, Professor G. I. Taylor, Professor D. M. S. Watson and Professor W. W. Watts.

ON November 18 a tribute from Germany was brought to Mr. Thomas A. Edison by Dr. Heinrich Jebens, president of the German Association of Inventors, who came to Mr. Edison's laboratory at Menlo Park. The certificate reads: "To the great master of technical development, the benefactor of humanity and the outstanding example for the inventors of the entire world, Mr. Thomas Alva Edison, we herewith tender an honorary membership in the German Association of Inventors."

DR. ALAN GREGG has been appointed director for the medical sciences of the Rockefeller Foundation. He will occupy the position vacated by the death on February 16 of Dr. Richard M. Pearce, Jr., in whose

work he had for many years closely participated as associate director for the medical sciences. Dr. Gregg first took up his work with the Rockefeller Foundation as a field staff member of the International Health Board in 1919. For three years he was actively engaged in public health work in Brazil. In 1922 he became associate director of the division of medical education. After making extensive studies of medical education in a number of countries, which included Colombia, Mexico and Italy, he was stationed at the Paris Office of the Rockefeller Foundation, from which since 1925 he has been directing Rockefeller Foundation work in the medical sciences in Europe.

PROFESSOR JULIAN HUXLEY, of King's College, London, spoke at the centenary celebration of the Boston Society of Natural History on November 18. Other speakers were Dr. William Morton Wheeler, a trustee; Dr. Edward Wigglesworth, the director, and Dr. Thomas Barbour, director of the University Museum at Harvard, a former president.

ON the occasion of the seventy-fifth anniversary of the Zurich Polytechnic Institute, honorary doctorates were conferred on Professor Albert Einstein, of the University of Berlin, who was formerly a student and a teacher at the school, and on Professor A. E. H. Love, of the University of Oxford, in recognition of his work on natural philosophy.

DR. JAMES BARNES, professor of physics of Bryn Mawr College, has been appointed head physicist at the Benjamin Franklin Memorial and Franklin Institute Museum, now being erected at Philadelphia. Dr. Barnes will assume his new work at the conclusion of the college year.

DR. L. T. COMRIE, a graduate of New Zealand and Cambridge Universities, has been promoted to the post of superintendent of the Nautical Almanac Office, Greenwich, England.

DR. JAMES CRAWFORD WATT, formerly associate professor of anatomy in the University of Toronto, has been promoted by the board of governors of that institution and given the full rank of professor of anatomy.

DR. B. L. VAN DER WAERDEN, professor of mathematics at Groningen, has been called to the university at Leipzig.

BYRON H. THOMAS, at present director of nutritional research for the Gordon Walker Company, has been appointed professor of animal husbandry at Iowa State College as well as chief in animal chemistry and nutrition at the experiment station at Ames.

DR. MAXWELL KARSHAN has been appointed associate professor of biologic chemistry at Columbia University.

PROFESSOR C. H. HOTCHKISS, in charge of the heating and ventilating work in the School of Mechanical Engineering at Purdue University for the last five years, has tendered his resignation effective on November 15, to become editor of the *Heating and Ventilating Magazine*, the principal journal of the heating and ventilating industry. Professor Hotchkiss will be succeeded by Professor W. T. Miller, who has been connected with Purdue University for several years, after experience in industry since his graduation in 1915.

MR. R. V. WRIGHT, of New York, managing editor of *Railway Age*, has been elected president for 1931 of the American Society of Mechanical Engineers. Mr. Wright succeeds Mr. Charles Piez, of Chicago, and will be installed at the annual meeting which will be held from December 1 to 5. Vice-presidents elected on the same ballot were Dr. Harvey N. Davis, president of Stevens Institute of Technology, Mr. William A. Hanley, engineering director of Eli Lilly and Company, Indianapolis, chemists, and Thomas R. Weymouth, president of the Oklahoma Natural Gas Corporation of Tulsa.

DR. LEONHARD STEJNEGER, of the U. S. National Museum, returned to Washington on November 4 after a three months' European trip during which he attended the International Zoological Congress at Padua, Italy.

DR. G. ELLIOT SMITH, University College, London, will deliver the third Harvey Society Lecture at the New York Academy of Medicine, on Thursday evening, December 4. His subject will be "The Peking Man."

DR. WILLIAM JOHN GIES, professor of biological chemistry in the College of Physicians and Surgeons, Columbia University, will give the Founders' Day address at the Medical College of Virginia at Richmond on December 1.

THE annual Gross lecture was delivered by Dr. William H. Woglom, of the Institute of Cancer Research, Columbia University, before the Pathological Society of Philadelphia on November 13 on "Experimental Cancer."

PROFESSOR ALEXANDER SILVERMAN, head of the department of chemistry of the University of Pittsburgh, delivered an illustrated lecture on glass before the Scientific Society of New Brunswick, N. J., on November 12.

DR. HARLAN T. STETSON, director of the Perkins Observatory, Ohio Wesleyan University, lectured during the month of November on "Sun Spots and Radio," before the American Optical Society of Rochester, the Pittsfield, Massachusetts, section of the American Institute of Electrical Engineers, and at Cornell University. He also lectured before the Brooklyn Institute of Arts and Sciences on "What are the Stars?"

DR. T. A. RUSSELL, president of Willys-Overland Limited, delivered his presidential address before the Royal Canadian Institute on "The Motor Car in World Affairs" on November 1.

SIR J. H. JEANS, of Trinity College, Cambridge, delivered the Rede Lecture on November 4, his subject being "The Mysterious Universe."

THE second Henry Herbert Wills Memorial Lecture in physics was delivered in the H. H. Wills Physical Laboratory, Bristol, on October 25, by Professor J. Franck, of Göttingen. The title of the lecture was "The Relation between Spectroscopy and Chemistry."

DR. G. FRANCHINI, director of the School of Tropical Medicine, University of Bologna, Italy, recently addressed the Association of Italian Physicians in America on the work of Alphonse Laveran.

DR. LUDWIG ASCHOFF, professor of pathology in the University of Freiburg, has been invited to give a series of lectures in the principal cities of Soviet Russia.

THE annual meeting of the Federation of American Societies for Experimental Biology will be held at McGill University, Montreal, from April 8 to 11, 1931.

THE second annual meeting of the Society of Rheology will be held at Lafayette College, Easton, Pennsylvania, on Monday and Tuesday, December 29 and 30. Programs, reservations and notices in regard to the meeting may be obtained from Professor Eugene C. Bingham, chairman of the Committee on Arrangements, Lafayette College.

THE first meeting of the Central States Forestry Congress called under the auspices of the state of Indiana will be held in Indianapolis on December 3, 4 and 5. This is the first concerted attempt of this group of states to organize a general forestry congress for the promotion of forestry activities in the region.

THE development of a nationwide program of research in cooperation with American universities as a next step in the extension of the activities of the National Committee for Mental Hygiene was announced as a major objective for the near future at a luncheon held on November 13 in New York City, in celebration of the committee's twenty-first anniversary. The effort will be made under the leadership of Dr. C. M. Hincks, medical director of the Canadian National Committee for Mental Hygiene and a vice-president of the International Committee for Mental Hygiene, who was introduced as the new general director of the organization, succeeding Dr. Frankwood E. Williams, who will retire on January 1 after serving fourteen years. At the business meeting immediately following the luncheon the following officers were reelected: *Honorary President*, Dr. William H. Welch; *President*, Dr. Charles P. Emerson; *Vice-presidents*, President James R. Angell, The Right Reverend William Lawrence, D.D., Dr. William L. Russell and Dr. Bernard Sachs; *Treasurer*, Mr. Frederick W. Allen; *Secretary*, Mr. Clifford W. Beers.

AT the Imperial Botanical Conference held on August 15 the following resolution was passed: "That an Imperial Botanical Conference take place in England in 1935, shortly before the International Botanical Congress which is to be held in that year in Holland." The following interim committee was appointed: The Director of Kew (convener); the Keeper of Botany, Natural History Museum; the professors of botany at Oxford and Cambridge; a professor of botany of the University of London (to be nominated by the chairman of the Board of Studies of the University); one representative of the Colonial Office, and one representative of the Dominion Office. It was further resolved that this committee summon a meeting of British botanists in the near future for the purpose of appointing an executive committee for the said conference.

Nature reports that a Scientific Advisory Committee on Medical Administration and Investigation has been appointed by the Secretary of State for Scotland "to assist the Department of Health for Scotland in applying the results of scientific research to the details of public health administration and in promoting such medical investigations as come within the sphere of the department or of the local authorities in Scotland." The members of the committee are: Dr. Alexander Bowman, scientific superintendent, Marine Laboratory of the Fishery Board for Scotland; Professor C. H. Browning, professor of bacteriology, University of Glasgow; Professor E. P. Cathcart, professor of physiology, University of Glasgow; Professor F. A. E. Crew, professor of animal genetics, University of Edinburgh, and director of the Animal Breeding Research Department; Sir Walter M. Fletcher, secretary to the Medical Research Council; Sir Robert Greig, secretary, Department of Agriculture for Scotland; Mr. John Jeffrey, secretary, Department of Health for

Scotland; Dr. J. Parlane Kinloch, chief medical officer, Department of Health for Scotland; Dr. A. S. M. Macgregor, medical officer of health, Glasgow; Professor T. J. Mackie, professor of bacteriology, University of Edinburgh; Professor J. J. R. Macleod, professor of physiology, University of Aberdeen; Professor Robert Muir, professor of pathology, University of Glasgow; Dr. J. B. Orr, director of the Rowett Institute for Research in Animal Nutrition, Aberdeen, and Professor W. J. Tulloch, professor of bacteriology, University of St. Andrews. Dr. Parlane Kinloch is chairman, and Mr. George Wallace, of the Department of Health for Scotland, is secretary of the committee.

A MILLION acres covered by heavy forest at the headwaters of Salmon River have been set aside as a "primitive area" by order of R. H. Rutledge, district forester. As such the tract will be kept as it was found by the pioneers, unmarred by roads or trails except as necessary for fire protection. It includes the Chamberlain Basin, the center of some of the best big game hunting in America. In it abound deer, elks, mountain sheep and goats and an occasional moose is found, while animals of prey, such as mountain lions, wolves and bears are frequently encountered.

Nature reports that a selection of the zoological and botanical specimens collected during Lord Howard de Walden's recent expedition to Uganda and the eastern Belgian Congo was exhibited at the meeting of the Trustees of the British Museum held at the Natural History Museum on July 26. The collection, which is the gift of Lord Howard de Walden to the National Collection, is one of the most important accessions received by the museum of recent years. The expedition left Fort Portal for the Semliki Valley on Feb. 17 last. Collecting was carried out within twenty miles of Lake Albert, and afterwards in a south-westerly direction to the Semliki Valley, crossing over into the Congo on Mar. 7. The route then led up the western escarpment of the Semliki Valley to Mboga and then west into the Ituri Forest. On Mar. 29 the expedition divided, one party proceeding south to Beni, the other going west to the Ituri River. Both parties came out of the Congo *via* Irumu and crossed Lake Albert into Uganda on the homeward journey during May. Lord Howard de Walden, in addition to spending some time with the expedition in the forest area, made a special trip to the Birunga Mountains lying to the northeast of Lake Kivu, with the object of photographing the eastern gorilla (*Gorilla gorilla beringeri*) and its habitat. The personnel of the expedition to the Ituri and Semliki Valleys, in addition to Lord Howard de Walden and Dr. Avery, consisted of Mr. R. Akroyd, who as well as organizing the expedition did valuable work as a collector of the larger mammals; Capt. F. A. B. Holloway, who concentrated chiefly on invertebrates, making a large collection of butterflies and other insects, and Mr. R. W. Hayman, a member of the museum staff, who specialized on the medium-sized and small mammalia. Two white hunters accompanied the expedition as guides and supervisors of the "safari." The mammals collected number 427 specimens, including 67 monkeys, 110 bats, 71 carnivores, 23 ungulates and 147 rodents. The reptiles and amphibians collected number 65 specimens, representing 31 species in all.

THE Berlin correspondent of the *Journal* of the American Medical Association writes: "The unsatisfactory demographic situation in Germany gave rise, in January, 1930, to the appointment of a federal commission on demographic problems. The chairman, Professor Gottstein, ministerial director, retired, has given his first report on the work accomplished. The commission is divided into three groups, each of which is directed by an expert. Group 1 is studying the problem of the birth rate under the direction of Professor A. Grotjahn, of Berlin, who has declared that relief from taxation is not in itself a sufficient means of solving demographic problems. He considers preferential economic treatment of the parents a more suitable method. By voluntary limitation of the number of children in families the number of living births in recent decades has dropped from 40 to 18 per thousand. Berlin, which has the lowest record, registered only 10 living births per thousand of population. Deaths in Berlin in 1929 exceeded the births by 10,000. The commonly assigned reasons for the voluntary limitation of the number of children in Germany (unemployment and the housing situation) are by no means convincing. The decline in the birth rate during the war period will, in a few years, lead to a dearth of man power in Germany. The fact is that during the years 1933–1937 there will be approximately two million fewer competent workers. This brings the senescence of the German people near. The second group of the commission under the chairmanship of Professor H. Sellheim, gynecologist of Leipzig, will seek to improve the protection of expectant mothers and of children as yet unborn. Group 3, under the chairmanship of Professor Rott, of Berlin, will study such problems connected with the preservation of the oncoming generation as infant welfare and the elimination of the preventable diseases. With regard to the tax reforms, the following demands are made: preferential treatment of families and children in the graduation of taxes on salaries, incomes, property and legacies, together with the es-

tablishment of a uniform exemption from taxation of at least 600 marks for each member of a family, with elimination of the present maximal sum for the whole family."

DISCUSSION

"MAD ITCH" OF CATTLE

THE observations made in this note are based on an outbreak of "mad itch" in a herd of dairy cattle in Johnson County, Iowa, in 1930. The disease is a rapidly fatal one, the interval in this outbreak between the appearance of pruritus or "itch" and death ranged from 36 to 48 hours.

The source of our experimental material was the brain tissue, preserved in glycerol, of three cows. The specimens from two cows produced no effect when injected subcutaneously into rabbits. The remaining specimen was effective, and on injection produced conditions resembling "mad itch" in cattle and death in a total period of 100 hours or less. The symptoms of pruritus appeared in from 70 to 80 hours after the inoculation and death followed 12 to 24 hours later.

Not only rabbits, but guinea pigs, white rats and mice are susceptible to inoculation. A difference has been noted in the susceptibility of the rabbit and the other animals. Subcutaneous injection is regularly effective in the rabbit, and intracerebral injection in the other species. Inoculations by other routes are irregularly effective in guinea pigs, rats and mice.

We have been interested in the experimental production of "mad itch" in small laboratory animals because through them an exhaustive study will be facilitated, and the nature of the etiologic or causative agent of the disease may be determined.

It is obvious that the agent is resistant to glycerolation. This is equally true of the infected rabbit and cow brain. No ordinary bacterial organism has by methods of culture and direct microscopic examination been discovered. On the other hand, suspensions of emulsified brain of rabbits, when passed through Berkefeld filters V, N and W, and Chamberland filter L^3, are all effective in inducing the experimental disease in rabbits.

The indications, therefore, are that "mad itch" in cattle is a disease communicable to laboratory rodents and its incitant is a filterpassing virus.

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THE SORTING POWER OF WIND AND WAVE

THE sorting power of streams of water—the power to sift out light or fine material from coarse or heavy material, such as dust, sand, gravel, etc.—has long been known and much studied. The sorting power of winds and waves is also a matter of common knowledge, but perhaps the effectiveness with which this process is carried on under favorable circumstances is not quite so generally known. The thoroughness of the sifting depends upon several factors, including especially differences in the size, shape and specific gravity of the particles, and, to a lesser degree, the slope of the surface and velocity of the wind or waves.

During the past summer we found on the shores of Bear Lake, Idaho-Wyoming, immense numbers of mollusk shells, chiefly *Carinifex*, with some *Lymnaea utahensis*, *Paludestrina*, *Valvata*, *Fluminicola* and other genera. On some portions of the shore the shells had been gathered by the waves into low windrows, or, to coin a more expressive term for the particular phenomena, waverows, from one to three or four inches deep and two to five times as wide. On a fine, sandy beach at the north end of the lake we scooped four quarts of shells by double handfuls from the top of the windrows and sacked them. In the laboratory we found that the shells had been so thoroughly sifted from the surrounding sand, by the waves, that there was only about a teaspoonful of sand left after separating out all the shells. On a similar beach on the west side we scooped up two quarts of shells out of which only three tablespoonfuls of sand were obtained. South of Garden City, on gravel, our collections contained coarse pebbles, in size roughly comparable to the shells, up to about 3 per cent. On the east side of the lake not far from the southern end, on a beach composed chiefly of well-rounded gravel of about the same average size as the shells but of course much heavier in proportion to bulk, we scooped up three pints from the windrows, which yielded 20 per cent. gravel, in bulk, much more in weight.

Near Thermal, California, a little hollow in the sand was filled with *Paludestrina protea*, *P. longinqua* and *Physa*, from which the fine sand had been so completely eliminated by the wind that in a lot of about 12,000 specimens scooped up by the hands there was scarcely a trace of sand. Near Brownwood, Texas, we found a ledge of limestone composed largely of foraminifera (*Fusulina*), which were weathering out rapidly. These were gathered by the wind into little depressions in the rock, the finer débris resulting from

the weathering having been almost completely eliminated. These are just a few out of numerous instances where shells and fossils have afforded data useful in the study of the sorting power of wind and water. Incidentally, they suggest the explanation of occasional occurrences of "pockets" and "streaks" of fossils in the rocks which would otherwise be very puzzling.

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A TERRESTRIAL AMPHIPOD IN THE UNITED STATES

A TERRESTRIAL amphipod, *Talitrus alluandi*, has been found in abundance in a greenhouse in Ohio. Besides its natural habitat, which appears to be the Indo-Pacific Islands, it has also been recorded from several localities in Europe, where it apparently has been carried and has become established locally. The most recent of these reports is one by K. Stephensen in 1924 on the finding of this organism in a greenhouse in Copenhagen.

The fact that the specimens under consideration were found in large numbers in a greenhouse in Columbus, Ohio, would lend support to the idea that this form has likewise been transported to this country and has survived for more than two years in an environment which simulates tropical conditions.

The specimens, measuring from two to four and a quarter millimeters in length, were found in great abundance in a greenhouse of the Fifth Avenue Floral Company, at Columbus, Ohio, by Mr. H. Walker, of the Ohio State University, and were given to the writers by Dr. Raymond C. Osburn. Search has been made in many other greenhouses but without success. They have, however, subsequently been cultured successfully in the laboratory at Cleveland.

It is believed that this is the first record of a completely terrestrial amphipod found within the United States. *Talitrus alluandi* was described by Chevreux in 1901, in the *Mem. Soc. Zool. de France*, 14: 389–393.

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PLANT LICE PUMPING IN UNISON

THE phenomenon, "flashing of fireflies in unison," discussed on page 132 in the January 31 and on page 537 in the May 23 issues, prompts me to report some observations of the curious behavior of aphids. These insects appear to lift their bodies simultaneously in the act of feeding, sucking the sap of a host plant. Following the theory described in the second discussion mentioned above, the insect on seeing his neighbor rise for inspiration or pumping may himself rise to keep in step and thus all in a like way tend to synchronism. But apparently incidence of light is not a motive, as the writer has placed a cardboard screen around the sides of an individual feeding in proximity to many others and this individual kept in step right on with the others, and even when there was a pause all along the line he paused too, and on recommencement of the lifting or inflating of their bodies in the act of sucking again, the screened individual was found to be in step as before, although he could not see any of them. It was noted that a colony of the insects rising in unison on a branch somewhat removed from another collection rising in unison on another branch did not coincide in moment, *i.e.*, each individual colony rose as a man, but did not rise in unison with the other colony.

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SPECIAL CORRESPONDENCE

A NATIONAL SYSTEM OF EXPERIMENTAL FORESTS AND RANGES

THE Acting Secretary of Agriculture recently approved a National Forest regulation which marks a new epoch in the forest-research work of the United States. The regulation is as follows:

The forester shall determine, define and permanently record a series of areas of national forest land to be known as experimental forests, sufficient in number and extent adequately to provide for the experimental work necessary as a basis for forest production or forest and range production in each forest region, these areas to be dedicated to and used for research; also where necessary a supplemental series of areas for range investigations to be known as experimental ranges; and a series to be known as natural areas sufficient in number and extent adequately to illustrate or typify virgin conditions of forest or range growth in each forest or range region, to be retained in a virgin or unmodified condition for purposes of science, research and education; and a series of areas to be known as primitive areas within which will be maintained primitive conditions of environment, transportation, habitation and subsistence, with a view to conserving the value of such areas for purposes of public education and recreation. Within any areas so designated, except for permanent improvements needed in experimental forests and ranges, no occupancy under special use permit shall be allowed, or the construction of permanent improvements by any public agency be permitted, except as authorized by the forester or the secretary.

The purpose of the experimental forests is to make permanently available, for silvicultural, range, products and other related forest research, areas as fully representative as possible of conditions in important parts of forest regions and large enough to meet present and foreseeable needs. In essence these areas are to be field laboratories for intensive investigative work. A secondary but hardly less important purpose is to provide for the demonstration of results, favorable or otherwise, of widely varying silvicultural and other forest practices. Each experimental forest is to be chosen on the basis that it adequately represents the subregion in which it is located as to forest types and sites and the conditions which underlie types and sites (such as soils, climatic variations and altitudinal range). Wherever possible each experimental forest is to include a "natural area" on which are to be preserved in an unmodified condition examples of the virgin growth of each forest or other vegetative type within each forest region, to the end that the region's characteristic plant and animal life and soil conditions shall continue to be available for scientific and educational purposes.

So far as can now be foreseen, from five to ten experimental forests will be required within each of the twelve or thirteen forest regions specified in the McSweeney-McNary Forest Research Act. Their areas will range from about 1,500 acres to about 5,000 acres, averaging about 3,500 acres, exclusive of the lands to be reserved as natural areas. They will not be so large as to impose any unnecessary burden of administration. Size will be governed primarily by the complexity of the type and by the growth rate of the tree species. The simpler the type and the higher the growth rate the smaller the area that will be required. In a subregion where it is not possible to find a satisfactorily representative single area it may be preferable to establish, as one unit, two or even three separate areas within easy working distance of the same headquarters.

For a natural area 1,000 acres is regarded as the minimum desirable under average conditions, but the acreage will vary with the type of forest involved or, possibly, with climatic and topographic conditions. About a dozen such areas will be required in each forest region. Where areas suitable for experimental forests or natural areas can not be found on existing national forests, consideration will be given to the possibility of acquiring suitable areas by gift or exchange or, as a last resort, by purchase.

Experimental ranges will be established under the same principles as experimental forests.

On the experimental areas scientific and educational uses are to be dominant, commercial utilization and public occupancy subordinate. On natural areas commercial use will be prohibited and public use will be restricted as far as practicable. For convenience of administration and protection the areas will remain essential parts of the national forests on which they are situated, but responsibility for their management and use will rest wholly with the directors of the forest experiment stations. The boundaries of the natural areas and the principles to govern their management are to be established by the forester and are not to be modified except with his approval.

While natural areas will be established primarily to meet the needs of the Forest Service, their use by other research or educational agencies for purposes which do not conflict with Forest Service projects will be allowed under appropriate cooperative agreements approved by the forester.

The readiness with which title to lands can be established under certain of the public-land laws gives rise to some uncertainty at present as to the ability of the Forest Service to safeguard the integrity of the experimental forests and ranges and the natural areas from adverse occupancy and use, but it is believed that as soon as the system has taken definite form and its vital importance to public welfare is established and recognized Congress will make legislative provision for preserving the areas permanently.

The reference in the regulation to primitive areas repeats the language of an earlier regulation under which a comprehensive system of primitive areas is now taking form on the national forest.

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U. S. FOREST SERVICE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

CULTURE MEDIA FOR OPALINIDAE

THERE seem to be three major desiderata in culturing Opalinids: (1) To supply predigested food. Without it I doubt the success of Larson and Allen's[1] experiments or any others. Despite Konsuloff's suggestion[2] that *Opalina* manufactures digestive enzymes and pours them into the "cecal" chamber of the frog host, there to aid in the further digestion of food for

[1] Larson and Allen, "Further Studies on the Reaction of Opalina to Various Laboratory Culture Media," *Univ. Kansas Science Bulletin*, 18: 8, April, 1928.

[2] Konsuloff, "Untersuchungen über Opalina," *Arch. f. Protistenk.*, 44, 3, March, 1922.

the Opalinas, we have no *evidence* of any digestion of any sort by Opalinids. (2) To avoid free oxygen in the culture fluid. (3) To avoid contamination of the culture medium. None of the several culture methods that have been suggested since the time of Pütter's first studies provide the first two desiderata mentioned. The third can perhaps be secured by frequent transfer of the animals to new culture fluid. Supplying predigested food or foods may not prove difficult. On the other hand, to keep the culture free of oxygen is not a simple problem. It requires a technique not yet developed, so far as I know, for culturing any protozoon, except such as will thrive with*in* an agar or gelatin medium. Frequent changing of cultured Opalinids to fresh culture fluid without introduction of considerable oxygen by exposure to the air involves still further technical difficulty. It could doubtless be done with the aid of a gas mask in an oxygen-free room.

Protoopalinae, when kept in Pütter's or Locke's solution, either with or without bits of the rectal wall of the host, show signs of abnormality within a few hours, often within four hours or so. The large, metabolic chromosomes in the huge nuclei of these binucleated Opalinids, when carefully observed by one familiar with their usual appearance, show features which I have interpreted as signs of abnormality. "Sweating" of these chromosomes along their edges begins and develops increasingly, beads of what seems to be chromatin, judging by the staining reactions,[3] appear and increase in size and number. These beads of chromatin sweat on the edges of the macrochromosomes have not been observed in the nuclei of Protoopalinas freshly taken from their host. It seems likely that they arise from an over-emphasis upon a normal process in the metabolic chromatin, making visible the sort of giving off of metabolic products that constantly occurs, only so slowly that they are carried off in liquid form as rapidly as they are developed. In addition to this sweating of the chromosomes, one observes in Protoopalinas kept a day or so outside the host a clumping of the chromatin in ways not noted in freshly taken material. This seems further indication of abnormal condition, as are, also, a slowing of the motion of the cilia and a delaying of the completion of fission, even when well started. These indications of "abnormality" can not be as well observed in the multinucleated Opalinids, whose nuclei, in all species, are much smaller than those in *Protoopalina.*

These facts, and the further fact that in this country Protoopalinas are available for study only in a few regions and in the northeastern states not at all, have made me hesitate to attempt to develop a culture medium and culture methods. Without detailed observation of the minute indications of abnormality in the nuclei, such as are seen in *Protoopalina,* it would be difficult to test adequately the fitness of the culture medium, and without confidence in the suitability of the medium conclusions from experiments with cultured animals are unsafe.

On the other hand, given a suitable culture medium and procedure, the prompt response by *Protoopalina* by visible cytological changes under unfavorable conditions might render *Protoopalina* a peculiarly favorable test animal for studies of protozoan physiology.

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[3] Feulgen's chromatin stain not employed.

RAPID STAINING OF PLANT TISSUES IN THE BUTYL ALCOHOL PROCEDURE

THE time and trouble involved in the preparation of sections, which have been lessened by the use of n-butyl alcohol as described by Zirkle,[1] may be reduced further by saturating the last stage of butyl alcohol with safranin and leaving the objects in it overnight, and by counterstaining the sections with Light Green S. F. in clove oil.

The second change in paraffin will remove all color except from the specimens, which will remain deeply stained and so may be readily oriented for sectioning. The sections on the slides, on being taken from xylene which dissolves the paraffin, should be dipped in a 1:1 mixture of absolute ethyl alcohol and xylene and then counterstained. The slides may be handled separately, in which case a drop of the clove oil solution of light green may be added from a glass rod. This should be flooded within a few minutes with xylene, the slide then redipped in the alcohol-xylene mixture and returned to xylene whence it can be mounted at leisure. If the spiral spring clip and Stender dish described by Chamberlain[2] are used, 15 slides may be handled at one time and should be immersed in the stain.

This method has proved simple, rapid and effective with the various stem tissues tried. With buttercup roots, however, it was found necessary to add a stage of absolute ethyl alcohol just before counterstaining and to leave in this stain half an hour or longer.

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[1] SCIENCE, 71: 103, 1930.
[2] "Methods in Plant Histology," Chicago, 1924.

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THE RELATION OF SCIENTIFIC RESEARCH TO AGRICULTURAL PROGRESS[1]

By Dr. A. F. WOODS

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A HALF century of service in finding and proclaiming facts underlying agriculture is a record worthy of the highest commendation. The world as well as the nation and the state have felt the helpful influence of the work of this station. It has been in the past and is to-day an active, helpful unit in the great federation of workers, ever seeking by new and improved techniques and clearer vision to give man surer control of those factors of his environment that make up what we call agriculture. It is a wide field, involving almost the whole range of our physical and biological environment, including man himself.

We may well pause at this half-century mark and ask how much we have gained through the development of natural sciences bearing on agriculture.

[1] Address at the celebration of the fiftieth anniversary of the founding of the New Jersey Agricultural Experiment Station, October 8, 1930.

A half century ago it looked to the best scientific minds as if increase in population would overtake and pass our power to produce food to meet the need. The zero hour was set at about 1933. The day is here. Populations have increased at about the ratio figured, but we can feed them all to-day more easily and cheaply than we could at any time in the past. There is less famine, less suffering, less hard work, and more leisure than ever before. The reason is that we have more accurate knowledge of the factors that must be controlled and we control them better than ever before in the history of man. This knowledge we have gained step by step through carefully planned experiments and the development of what we call scientific method, which is simply a method of trial by which we are able to measure and control each step or process and thus find the true relation of each factor under each set of controlled conditions.

From such observations modes of action can be determined and controlled and thus we formulate what we call our physical, chemical and biological laws. These laws operate with considerable certainty within the range of our observation.

It is this method that has given birth to what we call modern science. Some of it has grown out of a study of plants and animals under domestication, as Darwin's formulation of his theory of natural selection, Mendel's studies of inheritance of unit characters and his formulation of the manner of inheritance of such characters now known as Mendel's laws. These two deductions have given us greatly increased power to modify species and to make new ones embodying new unit characters and consequent qualities and to have these fixed true as in nature. But while nature may take a thousand years to produce a new species we can do it in a very few years or in some cases in a few weeks.

The plant and animal have become as plastic in our hands as the molecule and atom have in the hands of the modern chemist and physicist. A new world of interest and power has opened up to us that we have scarcely yet begun to explore.

This increased knowledge and power has been acquired not by spinning logical theories but by observing and testing and basing our hypotheses and theories on observed and tested facts.

In this work the agricultural experiment stations have been busily engaged for over half a century. They have as a result built up a body of experimental evidence in relation to almost every aspect of agriculture and country life that is gradually changing the whole aspect of agriculture in enlightened countries from a haphazard, rule of thumb work for peasants to a dignified, interesting and successful group of industries, able to hold their own, and to render efficient service in civilized society.

This may sound strange to ears that have for so long listened to the wail of the downtrodden farmer. It is necessary to use an intellectual grid screen to eliminate this static in order to get the true symphony of the new agriculture born of the scientific spirit.

THE SOIL

The soil to-day is not just dirt but a universe of life and activity, billions of organisms from the microphages—invisible under the highest powers of the microscope, bacteria, protozoa, microscopic algae, molds, fungi, and a multitude of higher forms, all engaged in breaking down and building up processes that all together make soil.

The factors that favor the fertility-producing and conserving processes are being discovered, as well as those that work in the opposite direction. We are learning to promote the helpful activities and to suppress the harmful activities. The chemists have discovered that out of all these activities there are developed certain colloidal substances that have much to do with what we call soil type. These colloids, with the organic matter which in the past we have lumped under the term humus, have a controlling relation to crop-producing power.

These and other factors are all considered in our soil surveys and land classification as a basis for a more highly developed and permanent agriculture and in reclamation procedures.

Then, too, we are beginning to realize the tremendous losses of fertility and waste of soil from slow as well as rapid erosion and we are beginning to take steps to prevent these losses as far as possible.

The New Jersey station is one of the foremost leaders in this soil research.

THE PLANT

The old botany was largely the naturalists' interest in the orders, species and varieties of plants as they occurred in nature. Down to the time this station was founded plants as well as animals were everywhere considered as fixed entities that might vary a little under changing conditions of environment, but always remained within the fixed bounds in which they were created.

As I have already suggested, this viewpoint has been changed as the result of research. We still have the families and species, but they are more or less plastic in the hands of the geneticist. We have learned that the hereditary characters are carried in the chromosomes of the germ plasm nucleus and that these chromosomes are made up of smaller bodies not much larger or more complex than some of our chemical molecules. We have learned that these have a definite relation to each other in the chromosome and that this definite relation controls the form and activity of the individual resulting from the egg cell.

Regroupings can be produced by crossing or hybridization or can be brought about by other means, such as certain forms of radiation, thus producing mutations in enormous numbers from which selections may be made. Much of this work has been done by our stations.

It is fundamental research that is giving us increasing control of these processes that nature uses in her evolutionary development. The time factor has been greatly decreased.

New corns, new wheats, new sugar canes, new cot-

tons, new varieties of grasses and clovers, new fruits, new flowers, have been produced by the thousands by controlled breeding. We now search the earth for plants having unit characters that we may need as well as already developed varieties. Cold and drouth-resistant wheats and alfalfas, wilt-resistant cottons, cowpeas, flax, melons, sugar canes resistant to virus diseases, potatoes resistant to these and other diseases have been produced. The plant breeders are constantly improving, developing and adjusting crop plants to various limiting factors and quality requirements.

We have long realized how fundamentally important plant life is to the existence of animal life. We know that plants are able to combine carbon, hydrogen, nitrogen into forms available to animals. They do this with energy absorbed from sunlight. We have known a little of these products of photosynthesis, starch, sugar cellulose, pectin, organic acids, and a host of other organic products about which we know very little.

Recently our station investigators have opened up a new field in the so-called vitamins that are found to have extremely important relations to animal development. They control growth and reproduction, resistance to many diseases in animals and man. Almost every year our investigators are bringing new aspects of these important matters to light.

Then there are other light relations that have only recently been discovered, *viz.*, the relation of periodicity of light exposure to the development of plants. In nature this is regulated by the seasons and by day and night. We have developed some control of resting periods and growth, but flowering and fruiting in the majority of cases could not be controlled until one of our scientists discovered that by changing the length of exposure to light and darkness he could change the flowering and fruiting period. This is proving to be a most helpful control in bringing plants to bloom at a desired period, either for commercial or research purposes. It is a new field in which there is research yet to be done.

There are many chemical processes carried on by plants that yield extremely valuable food and medicinal products that have been produced with difficulty or not at all by the biochemist in his laboratory. In some cases it would be extremely valuable to be able to produce these more cheaply and rapidly than can be done by plants.

Among these is an organic poison known as rotenon, produced by a number of tropical shrubs and extremely valuable as an insecticide because it is not poisonous to the warm-blooded animals and is extremely poisonous to insects both as a contact and stomach poison. If we could find out how this is synthesized in the plant it might give us a clue to chemical synthesis in the laboratory and this in turn might lead to efficient commercial production.

The same is true of nicotine, another valuable insecticide, but more or less poisonous to higher animals. The supply available from tobacco waste is not sufficient to meet the requirements. A synthetic material very closely related but not quite so effective as nicotine has been developed but we hope to improve on it.

Bacteria of certain types are able to fix atmospheric nitrogen and make it available to higher plants. The process is rather slow but the method is far more efficient than anything we yet know in our laboratories, with all the improvements we have made in the past few years. How does the bacterial cell accomplish this fixation? If we can find out perhaps it may suggest further improvements in our laboratory and commercial processes.

These examples will indicate the great importance of research in these fields.

Our plants, like animals, are subject to disease. Disturbances in nutrition, attacks by bacteria and fungi, and the filterable viruses cause hundreds of millions of loss every year.

A new science, phytopathology, has been developed in our efforts to cope with these diseases. The first progress along control lines was in the use of fungicides. The U. S. Department of Agriculture and the experiment stations have led the world in this development. The same is true in regard to insect pests. The warfare grows more intense every year. The increasing ease of communication between hitherto isolated regions has made it possible for many fungous and insect parasites to move to cultivated plants related to their wild hosts. With the improved food conditions they multiply enormously and become major pests. Plant lice, leaf-hoppers, grasshoppers, crickets, potato beetles, are all well-known examples of those that have moved from wild to cultivated plants. The cotton boll weevil, the pink boll worm, the Japanese and Asiatic beetles, the corn borers, the Mediterranean fruit fly, and others too numerous to mention, are some that have been brought in. Here, free from their enemies, they have become a serious menace to our agriculture. Most of them can not be eradicated, so the best that we can do is to import their enemies when those enemies are not likely to be injurious, and also to develop other means of suppression and control.

This involves a careful, detailed study of the life and habits of all these pests, but it is the only hope

of successfully keeping them in check in highly developed agricultural regions.

The same is true of plant parasites, rusts, smuts, mildews, bacteria, and hosts of others. One little fungous parasite is rapidly killing off our chestnut forests. No adequate means of control has been found. A destructive elm disease is knocking at our doors, and there are many others known and unknown that must be kept out. But I must not linger in this fascinating field, though I have barely touched it.

ANIMAL INDUSTRY

Another phase of our agriculture of outstanding importance is animal husbandry. It transforms the lower-grade food products into those of higher value —milk, butter, meat and by-products. The progress that has been made in animal breeding is well known to all.

In recent years, however, much greater efficiency has developed in breeding for efficiency of performance in a desired line rather than for certain unimportant characters. Our stations and the U. S. Department of Agriculture have led in developing these methods through more careful application of the laws of genetics.

In the field of animal nutrition great advances have been made—the balanced ration, the relation of the quality of the ration to the quality of the product, the discovery of vitamins, all grew out of this work, and it is only in its beginning.

Very great contributions have been made in the study and control of animal diseases. Perhaps the outstanding contribution was the discovery by workers in the Bureau of Animal Industry of the Department of Agriculture that a microorganism found in the blood of cattle suffering with a disease known as Texas fever was the cause of the disease and that the cattle tick is the means whereby this disease is transmitted. This was the first demonstration that a microbial disease could be transmitted through the intermediate host or carrier.

This discovery ranks among the great achievements of medical science. It led to the discovery that other diseases, like malaria and yellow fever, are carried by mosquitoes, typhus fever by lice and other insects, African sleeping sickness by a fly, Rocky Mountain fever by a tick, etc.

This knowledge gave the key to the development of methods of eradication and control.

As stated in the Yearbook of the U. S. Department of Agriculture, 1930, studies begun in the same bureau in 1885 showed that resistance to disease could be produced by injection of killed cultures of the organism causing it. This led to the development of the method of vaccination against typhoid fever and other bacterial diseases.

Many other fundamental researches on animal diseases have been made by the department and the stations that have been of inestimable value not only to agriculture but also in the treatment of the diseases of man.

In the field of animal parasites an outstanding example was the discovery by a department scientist of a new species of hookworm that attacked human beings in our Southern states and many tropical countries. Effective remedies were also discovered by the department.

Through the efforts of the International Health Board of the Rockefeller Foundation the methods have been used in many millions of cases in all parts of the world. Bovine tuberculosis, hog cholera, and a host of other diseases have been investigated and important progress made in controlling them. No branch of the work of these institutions has rendered more important service to agriculture and to humanity or offers greater promise of future service.

It is a mistake to say that the work done by the Department of Agriculture and the experiment stations is for the benefit only of a class or in the interest of pigs and corn. It is of direct service to every man, woman and child in America, and I think I may safely say in the world, as scientific discovery knows no bounds. It belongs to all the world.

Recent legislation has enabled the department and the stations to study more deeply in the economic and social fields. While great contributions have been made individually in these fields by the department and the experiment stations very little thoroughgoing, systematic study has been carried out. Much, however, is now being organized and we may look in the future for a more scientific basis for our economic and sociological planning.

All the great undertakings, including industries and business, rest upon carefully ascertained facts. They have their scientific agencies to get the facts and to search for still more facts and means of applying them to advantage.

Agriculture spends through the Federal Government and the experiment stations close to $30,000,000 a year for a $60,000,000,000 group of industries, with an annual turnover of $10,000,000,000. This investment has made American agriculture, with all its shortcomings, the best in the world. Other industries spend nearly $200,000,000 for research and the amount is increasing yearly. It is the way of progress and safety and offers most for the present and future welfare of man.

THE LANGUAGE OF SCIENTISTS[1]

By the Reverend GEORGE W. LAY
CHAPEL HILL, NORTH CAROLINA

HAVING been a student of language for many years and observant especially of the language of scientists, I thought that a paper on the subject might prove both appropriate and interesting. Scientific specialists are not always interested in papers on other specialties, but all are interested in interpreting the language of nature. The knowledge thus acquired must be passed on to others by means of the written or spoken word. All should therefore wish that such ideas should be expressed in language clear and accurate, and worthy of the great cause of science. Especially is this true when we reflect that many of us are teachers. Therefore I hope that you will be interested.

I was a little doubtful of the propriety of my choice of subject, until I found that in the program of the American Association for the Advancement of Science, to which doubtless many of us belong, Section L is devoted to "historical and philological sciences," and the proceedings of the last meeting of the association record what was done under the head of "the linguistic sciences part of Section L." Hence I hope my subject is a proper one for this body.

Lawrence W. Wallace, of Washington, D. C., secretary of the American Engineering Council, is quoted in SCIENCE[2] as saying: "Men of science . . . by supplementing with broad humanistic and scholarly interests the technical genius responsible for the Machine Age . . . are becoming a controlling force in culture and in politics no less than in commerce and industry, in finance, in education and in national defense." He mentions that the President of the United States, two members of his cabinet, many members of the two houses of Congress and ten governors of states, including our own governor of North Carolina, are men of science, or hold scientific degrees, or both. If they are to be leaders in culture, the responsibility of scientists to cultivate and use the best English would seem to be very great, in spite of the very natural temptation to regard language as something foreign to their own specialties. They need to acquire a linguistic conscience, a sensitive ear and a wise discrimination, as they hear or speak or write the English language. Then consider the great harm that may be done to vast numbers of the younger students of science if they carry from the classroom slovenly, or absolutely incorrect, modes of speech. Once a charming co-ed graduate student, after telling of the gross mistakes of her learned scientific professors, including mention of one "Ar chím edes," with mournful tones said to me, "I sometimes despair of the future of the English language." I am not so pessimistic as she, but I do think we need to be very careful.

Allow me first of all to call attention to some of the mistakes into which we are liable to fall when from carelessness or inadvertence we follow the vulgar crowd. There is a tendency in America to accent the first syllable of many words where true culture demands an accent on the second syllable. If we say, and even defend, "ré search," "ré sources" and the "U′nited States," we shall have plenty of support, but not from those who are most cultivated in their speech. Also, if we are consistent, we must say ád dress, dí rect, dís charge, éx cess, hó tel, mág azine, moús tache, úm brella, Dé troit, Sé attle, cí gar and cíg arette.

Another common tendency in America is to give a word two accents, where only one is proper. I once lived in a city where some of the streets were named after trees. Several of my friends lived on what they called "Sassy Frass Street." I never found its companion, "Polite Frass Street." The worst example is "Hoss Spittle." Of course none of you say this, but notice your friends carefully and you will find that most of them so pronounce it. It is a most uncomfortable word, and reminds me of my youthful experiences when driving against the wind in the old horse-and-buggy days. Millions of our boys, being familiar with speedometers and cyclometers, brought back from France the word *ki-lom′eter*. This has been taken up by some scientists. Soon we shall be hearing of cubic *centimeters*, and then of *kilogrums*, to agree with those perfectly horrid words, *progrum* and *telegrum*.

Many words are distinguished as nouns or verbs by taking an accent on the first syllable as nouns and on the second as verbs. Pronounced as verbs, some of them are as follows: ac-cent′, af-fix′, pre-fix′, suf-fix′, con-trast′, con-tract′, ex-tract′, in-crease′, con-test′ and con-vict′. It may please you for me to confess that I had been teaching the intricacies of Greek ác-cent for many years before I learned that I must teach my pupils how to ac-cent′.

A lack of knowledge of the classic languages, or

[1] A paper read before the North Carolina Academy of Science at Duke University, May 9, 1930.

[2] "Engineers in American Life," SCIENCE, 71: 28, January 10, 1930.

carelessness in the use of what little knowledge one has retained, leads to many regrettable blunders. Words of the fourth declension in the Latin are sometimes used improperly, and the English plurals of words from Latin or Greek are used incorrectly. One can not preserve the *statu quo*, or keep things *in status quo*. One can say "many apparatus" or "many apparatuses," but not "many apparati." "Many alibi" is also indefensible. I have read the frenzied defense of "this data is"; but for one with a linguistic conscience it simply isn't done. If one can agree with that defense, it would seem fair to excuse even the Harvard professors whom I have heard say "a strata" and "a suitable media."

If one is going to use a phrase or word from a foreign language, it is quite necessary to know the meaning in that language. Otherwise many mortifying mistakes will be made. By most people *per* and *via* are thought of as simply meaning "by," with no distinction between *per*, "by means of a specified agent," and *via*, "by a specified route." But one sometimes reads of things sent *via* Mr. Smith.

Then the French word *née* is equivalent to the Latin *nata*. It is feminine and means "born." It is properly used in giving a woman's maiden name, which is the only one she has at birth and the one that frequently she is quite willing later to discard. In the description of a widow's second marriage I have heard of Mrs. John Jones, *née* Mrs. Samuel Smith, *née* Miss Mary Robinson. This seems to be carrying the idea of regeneration to a rather unwarranted extreme. And in the *Popular Radio Magazine*, a supposedly scientific periodical, I found this delicious bit: "Leningrad, *née* Petrograd, *née* Saint Petersburg." Of course these writers thought of *née* as simply meaning "formerly," and let it go at that.

With a friend of mine, who kindly allows me to use the occurrence as an illustration, I had a conversation which shows the necessity of a scientist's having at least sufficient knowledge of Greek to be able to look up words in a Greek dictionary. He asked me whether *Rhizopogon parasiticus* was correct. The former word looks like a common neuter form. Should *parasiticus* be masculine? Now many of the scientific Greek words for genera are not found in ordinary Greek literature. I could not answer the question offhand. There was a large room full of all kinds of books on botany, but no Greek dictionary. I asked him, "Do you say rhizó pogon or rhizopó gon?" He answered, "I say *rhizopó-gon*, but I don't know why." After consulting a Greek dictionary at home I was able to tell him that *rhizopogon* was masculine in Greek and that each of the last two "o's" was omega, or long "o," in Greek, and that therefore the penult took the accent. He was correct about both points, but could not be sure. He then showed how a little learning is sometimes a dangerous thing. He asked me the derivation of "pyrenomycete," saying that of course *pyr* meant fire. I said, "I am not sure of that. Where would you get the *eno*?" This time I only had to consult a big English dictionary, verifying the information by the Greek dictionary. So I told him that the chemical term "pyrene" was indeed from "pyr," but that the botanical term "pyrene" and the combining form "pyreno" were both from the Greek stem *pyreno*, meaning the stone of a fruit, as of a drupe or drupelet.

An example of ignorance or carelessness appeared in an important paper by an eminent scientist that was published in SCIENCE. Carnivora, herbivora and omnivora are neuter plurals, but they have the same ending as many feminine singular nouns of the first declension in Latin. This paper spoke of the carnivorae, herbivorae and carnivorae, and rubbed it in by using herbivorae again on the same page. When I asked the writer about it, he acknowledged his carelessness, but made the plea in extenuation that SCIENCE printed it that way. This was a pretty hard knock on SCIENCE.

An interesting point about homonyms, or words that are pronounced alike but differ in spelling and meaning, was brought out by a geological friend who said that to distinguish between syenite (or sienite) and cyanite he pronounced the latter with a hard "c," like "k." I said, "You can't do that. Before that vowel sound 'c' must be soft; but you can say 'kya-nite,' if you spell it so, that being a permissible form of the word."

Scientists are overwhelmed by the vast number of new facts discovered and the many new theories or explanations of these facts. In each such case a new word must be devised to express the new idea. These words are practically always derived from the Latin or the Greek, of which languages scientists are, as a rule, largely ignorant. The English dictionaries are often of no help, since the words are invented and come into general use long before the dictionaries can put them into print. There would seem to be immediate need for some central authority to determine correct terminology and the proper and exact meaning, spelling and pronunciation of new words. I mention certain obvious points.

Mongrel or hybrid words constitute a linguistic crime. Generally speaking, a word should be all Latin or all Greek. To be sure, some combining forms from the Greek have been so completely naturalized in Latin and English that they may be used indiscriminately. Such forms as *pro-* and *anti-* and

-ology are examples. We even say "Roentgenology." But there is no palliation for the linguistic crimes of "hypersensitive" and "hypertension" when we can say "supersensitive" and "supertension," or "television" when we might have invented something like "teleopsis."

Such a central authority could insure that every new word had a perfectly definite and exact meaning which would be recognized by all scientists. Attention has been called recently to two examples of unscientific confusion in the meaning of words. It is asserted that "micromicron" is used by physicists with one value and by biologists and chemists with another. One value is a thousand times greater than the other. Then some one has invented another word, the "bicron," all by himself. I have met no scientist who had heard of it. Yet it has crept into some dictionaries. Likewise the symbols for micron, millimicron and micromicron do not seem to be settled in a way universally accepted. The U. S. Bureau of Standards is definite and precise in this regard, but seems to lack the respect of some. The other example is the word "pedology." The soil men derive it from a Greek word meaning earth. Some one points out that this is a very recent use of the word, and that it has been used for over thirty years to mean child study, with a derivation from another Greek word meaning child, like "pediatrics" and "orthopedics," which are not derived, as many suppose, from the Latin word for foot. Next a soil man tells me that pedology was used by the Russians and other European scientists to mean soil science long before it was used for child study. Surely science should not allow such confusion.

Nomenclature is an exceedingly important subject. So important is it that in the account of creation in the second chapter of Genesis we are told of the first authority on nomenclature. The animals were brought to Adam "to see what he would call them. . . . And whatsoever Adam called every living creature, that was the name thereof." I am far from regarding this account as a literal record, but at least it shows an early recognition of the importance of correct names in science.

Not only should scientific names be definite; they should also be as simple as possible so as to be easy to remember and pronounce. In Science for January 10, Professor James G. Needham, of Cornell University, mentions a poor little innocent amphipod crustacean that is burdened with the name *brachyuropushkydermatogammarus grewinglii mnemonotus* Dybowski, and a very small fish named *microstomaticoichthyoborus bashford-deani* Nichols and Griscom. It sounds like a college cheer. He objects to having to manage such jawbreakers and claims that a name is a name to call a thing by, and not a definition or a memorial to a discoverer. Instead of the former of the two examples of sesquipedalianism he proposes *Gammarus mnemonotus*, and nothing more, as being definite, simple and quite sufficient. I am sure it would also be more pleasing to the dear little member of the Gammaridae not to be called hard names.

Finally I wish to say that I fully appreciate the difficulties under which scientists labor. Little help is given in scientific books as to derivation or pronunciation. It would be well if all scientific textbooks at least gave both the derivation and the accent of words derived from foreign languages. Scientists can not even trust each other. I am told that the same word may be pronounced in one meeting in one way and in quite a different way at another meeting held shortly after in another part of the country. My sympathy is the greater and more genuine since I am all the time discovering words that I have mispronounced for many years.

This is preeminently a scientific age. Scientists are leaders. I hope that I have helped to make clear the great opportunity presented to all scientists to be leaders in culture, as well as in the ascertainment of facts and the explanation of phenomena.

OBITUARY

MEMORIALS

William Barton Rogers, first professor of natural philosophy at the University of Virginia, will be honored on December 7 by a ceremony at which the presidents of two institutions will speak. The Technology Club of Virginia, composed of alumni of the Massachusetts Institute of Technology, will unveil a bronze tablet in the Cobb Chemical Laboratory, commemorating Rogers's connection with the University of Virginia and with the Massachusetts Institute of Technology. Rogers, who was a member of the Virginia faculty from 1835 to 1853, went to Massachusetts where he founded the institute in 1859, to serve later as its first president, from 1865 to 1870, and again during the years 1878 to 1881. The dedication exercises will take place in the Cobb Laboratory on Sunday, December 7, the one hundred and twenty-sixth anniversary of Rogers's birth. The presentation will be made by Mr. J. Scott Parrish, Richmond, president of the Technology Club of Virginia. Acceptance for the university will follow by President Edwin A. Alderman. The services of Rogers to Virginia will be

described by Dr. Llewellyn G. Hoxton, head of the school of physics, third occupant of the chair originally held by Rogers. Dr. Samuel W. Stratton, chairman of the board of the Massachusetts Institute and former president, will deliver the address in which Rogers's contributions to the institute are described. The tablet is to be installed beneath an oil painting of Rogers which was done in 1881 and which hangs at present in the Cobb Laboratory. This painting was one of the few things saved when the former laboratory burned to the ground. It suffered only slight damage.

THE building for geology at the University of Missouri has been named George C. Swallow Hall in honor of George Clinton Swallow, first professor of geology in the university and first state geologist of Missouri. Dr. Swallow went to the university in January, 1852, as professor of chemistry, geology and mineralogy. In 1853 he was appointed state geologist, resigning from the university faculty. Later he returned to the university as professor of agriculture. A monument in the Columbia Cemetery, where he was buried, calls him the "first professor of geology, chemistry and agriculture, and the first dean of the College of Agriculture in the University of Missouri, and the first state geologist of Missouri." The monument was erected by the Boone County Historical Society in 1928.

A SCHOLARSHIP has been founded at University College, Southampton, by friends of the late Dr. Alex Hill, in recognition of the distinguished services rendered by him as principal of the college. Previously Dr. Hill had been professor at the Royal College of Surgeons, and master of Downing College, Cambridge.

A MEMORIAL address of the character and work of the late Sir H. Baldwin Spencer was delivered on October 31 in the museum by Mr. T. K. Penniman, president of the Anthropological Society of the University of Oxford.

THE *Journal* of the American Medical Association reports that a bronze portrait bust of Louis Pasteur, through the will of Dr. Arthur C. Hugenschmidt, a friend, who died in Paris last year, has been sent to the University of Pennsylvania. The bust was first placed on public view in the school of medicine, October 10, when a two-day celebration commemorating recent progress in medicine was opened. Dr. Hugenschmidt, dentist to Pasteur, was presented with the bust by Madame Pasteur.

THE council of the senate recently reported to the University of Cambridge on a proposed James Clerk Maxwell centenary celebration. A committee of eminent men of science and others have suggested that the university should celebrate the centenary of his birth, which occurred on June 13, 1831. The suggestion has been approved and it is recommended that the centenary should be celebrated on October 1 and 2, 1931.

RECENT DEATHS

DR. GUSTAVE MAURICE BRAUNE, since 1922 dean of the school of engineering at the University of North Carolina, died on November 26, at the age of fifty-eight years.

DR. JOHN L. TILTON, professor of geology at West Virginia University, died in his classroom on November 17. He was sixty-two years old.

HARRY CHAPMAN WARDELL, curator of industrial science in the Rochester Municipal Museum of Arts and Sciences, died on November 18.

DR. RICHARD MOLDENKE, consulting metallurgist, formerly of the U. S. Coast and Geodetic Survey and of the Michigan College of Mines, died on November 17, at the age of sixty-six years.

THE death is announced in a Reuter message from Wellington, New Zealand, of Robert Julian Scott, emeritus professor of engineering at Canterbury College, who was head of the School of Engineering from its foundation in 1889 until he retired in 1923. Professor Scott was sixty-nine years old.

THE deaths are announced of M. Philippe Glangeaud, professor of geology at Clermont-Ferrand, member of the section of mineralogy of the Paris Academy of Sciences, and of M. Emile Godlewski, honorary professor of physiological botany at Cracow, correspondent in the section of rural economy.

CAPTAIN OTTO SVERDRUP, the Scandinavian explorer, died at Copenhagen on November 26, at the age of seventy-six years. He was a close associate of the late Dr. Fridtjof Nansen.

DR. SCHEVIAKOFF, the Russian zoologist, especially known for his work on the Protozoa, died at Irkutsk on October 18.

SCIENTIFIC EVENTS

PANEL OF EXPERT TRANSLATORS

THE Association of Special Libraries and Information Bureaux, of which Sir Joseph J. Thomson is president, announces a scheme whereby the association will act as intermediary between translators and users by establishing a panel of translators possessing the

double qualifications of proficiency in one or more languages and expert knowledge of one or more subjects.

A translator who wishes to be registered on the panel is required to answer a questionnaire (which can be obtained by application to the secretary of the Association), which is framed so as to provide the association, in addition to necessary particulars, with full information regarding the applicant's qualifications, linguistic and technical. Applications are considered by a board, whose decision is final. In certain cases the board may require the applicant to submit to a test. As a rule only individuals are eligible for registration, but commercial translating bureaus may apply for registration in respect of full-time employees, or by satisfying the board of their ability to undertake high-class specialized work.

An applicant may apply to be registered for any foreign language and for any number of foreign languages, but a high standard will be required by the board. A "fair" knowledge of a language will not be accepted, except in special circumstances, for example, where, without possessing a general knowledge of a language, an applicant has special knowledge of some technical terminology in it.

An applicant may apply to be registered for any subject and for any number of subjects, provided that these are sufficiently specialized. What is meant by "sufficiently specialized" can not be closely defined. Broadly speaking, the "commoner" the language the higher will be the degree of specialization required. An applicant fully qualified in a "rare" language, such as Chinese, Hungarian, or Turkish, might be accepted with little or no specialized knowledge of any subject. Applicants must use their judgment in this matter and give as much information as possible. If in doubt they may, before completing the questionnaire, send in an inquiry as to whether their subject is likely to be acceptable to the board. All branches of knowledge—science, law, the arts, etc.—come within the scope of the scheme.

The panel should include translators living in any part of the country and applications are considered from those living abroad. Part of the value of the scheme to users is that, in cases where time is an important factor, it may be possible to put them into touch with a suitable translator living in their own locality. On the other hand, when the question of time is less serious and the subject-matter particularly difficult it may be worth while to send the work abroad.

Included in the panel are those who are prepared to act as interpreters. The need for this kind of assistance arises frequently when interviews take place between English people and foreign visitors. Often they know no language in common or their knowledge is not good enough to enable them to discuss technical matters.

The panel is a private register belonging to the association, and it will not be published. To members of the association the service is available without charge. To others a charge is made in respect of each name and address given. Once the association has served the purpose of effecting the introduction, which may establish a permanent connection of value to both parties, its interest in the matter ends.

THE INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

M. Charles Lormand, of Paris, contributes to *Industrial and Engineering Chemistry* an account of the tenth conference of the International Union of Pure and Applied Chemistry, held in Liége from September 14 to 21, and of particular significance in that it became truly international. The German chemists, who at the preceding conference at The Hague had been invited to join the union, in the meantime had formed in Germany a federation of chemical groups. This federation sent to the Liége conference an important delegation composed of the most distinguished German chemists.

The union decided this year to suspend the activities of its committees, which had been censured for their concentration solely upon administrative work. Certain committees had been dissolved because of these criticisms. They will now, however, resume their full activity in the more extensive field of the congresses which they will call together.

This year a series of reports on sugars was placed in the order of the day. The president of the scientific committee of organization of the union, Professor Délépine, had asked several representative chemists to give reports, followed by discussions, on the results they had achieved in this field. The series of conferences which was thus held in Liége included all aspects of our present knowledge of the chemistry of sugars, starch and cellulose. Gabriel Bertrand, in the first report, gave the present status of our theoretical concepts of the constitution of sugars, and, in the course of the three days which followed, Messrs. Haworth, S. Hudson, T. M. Lowry, Smith, A. Pictet, Karrer, H. Pringsheim, H. Mark, Emil Heuser and Ettore Viviani reported in succession on the structure of sugars, the relation between the constitution of sugars and their rotatory power, the constitution of starch and of polysaccharides, molecular weights and the use of X-rays in the study of structure, the constitution and properties of cellulose and lastly on the constitution and physical properties of artificial silk.

Each of these reports, given in the language of the author, was followed by a discussion, first in French, then in English and later in German.

The union recorded the forthcoming entry of Swedish chemists.

The International Bureau of Physico-Chemical Standards, a section of the union, reported that more than two hundred samples of calorimetric standards have been distributed to different industrial laboratories. In this connection, a permanent committee on thermochemistry has been formed for the purpose of studying the use of salicylic acid as a secondary standard.

The Committee on Nomenclature of Inorganic Chemistry met under the presidency of Professor Hollman and discussed the different reports presented by Professor Grillart. No change will be made in nomenclature so long as the edition of Beilstein is unfinished. The plan will be drawn up by chemists universally and the bases of nomenclature which are now in use will serve as practical terminology until the new order is established.

Various modifications of statutes required by changes in the statutes of the International Research Council were approved.

The former Committee on Chemical Elements was then dissolved and replaced by three committees. One, the International Committee on Atomic Weights, will publish an annual atomic weight table. This committee is composed of the following persons: Mr. Urbain, honorary president, Mme. Curie, Messrs. Baxter, Hoenigschmidt, Lebeau and Meyer. A second committee, known as the International Committee on Atoms, will study the question of atomic structures. A third Committee on Radioactive Substances, in conjunction with the Committee on Radium Standards, will study radioactive substances solely.

The International Committee on Atomic Weights plans to publish an international table as soon as possible. This is to be the only official table, and to this end atomic weight sections of each separate country will refrain from publishing national tables.

The union will hold its next session two years from now in Madrid; the 1934 session will be held in Switzerland. The union will thus continue to meet every two years. Furthermore, it has decided to resume its international congresses, the last of which met in New York in 1912. Owing to the war, the 1914 congress, scheduled for Moscow, could not be convened. The next congress will be in Madrid in 1932 during the conference of the union. It will be international and will embrace all branches of chemistry, pure and applied. As in the Liége session, a certain number of questions will first be placed in the order of the day and different sections of the congress will receive a limited number of reports. One special committee will be authorized to accept or reject these reports, which should, of necessity, be of truly international interest, and should not duplicate publications which a chemist might present through his national society. In the details of organization of the congress, considerable attention was given to the report of Bernhard Hesse on the Eighth International Congress, and as a result problems, no matter how interesting, will be barred from the session if they are not of international significance.

INTERNATIONAL CONGRESS ON BITUMINOUS COAL

A THIRD international conference on bituminous coal will be held at the Carnegie Institute of Technology in November, 1931, according to a recent announcement made by President Thomas S. Baker, who organized the first two international congresses.

An invitation will be extended to the scientific men of all countries to take part in the meeting, which is the only one of its kind of international scope. Prominent men of affairs in America will assist Dr. Baker in organizing the meeting.

The purpose of the congress will be similar to that of the meetings held in 1926 and 1928: to present for discussion the results of recent studies of coal. Particular attention will be paid to the economics of the new methods and processes that are being evolved, he indicated.

The program will include papers on carbonization, liquefaction and gasification of coal, by-products of coal, the mechanism of combustions, cleaning of coal and its preparation for the market, pulverized fuels, power plants and domestic heating. The discussions will be confined to coal above ground. Beginning at the mouth of the mine, however, practically every phase of distribution and consumption will be treated by outstanding authorities in the several fields.

"The condition of the coal industry during the past few years can hardly be called healthy," President Baker said, "and the current business let-down has brought extreme depression to this basic world industry. We hope that as a result of the discussions held we may be of assistance in uncovering new processes which may help it on the road to recovery."

Announcement of this third world meeting comes in logical sequence to the previous congresses. The first conference was organized by President Baker in 1926 for the purpose of finding new uses for bituminous coal and especially to discuss the problem of liquefying coal to supplement the petroleum oil supply of the world. This meeting, although it was the first of

its kind to be held, attracted 1,700 investigators from thirteen different countries. Two years later followed the second congress which was broader in its scope, including discussions on pulverized fuel, low temperature carbonization of coal, rubber from coal, the hydrogenation of coal and by-product nitrogen. Speakers during the two conferences have included M. Georges Claude, Dr. Friedrich Bergius, Professor Franz Fischer, Dr. C. H. Lander, Dr. R. Lessing, General Georges Patart, Dr. Fritz Hofman, Dr. Karl Krauch and many other fuel technologists.

AERONAUTIC RADIO RESEARCH AT THE BUREAU OF STANDARDS

THE development of radio aids to aviation is being forwarded through work of the National Bureau of Standards, which is operating also as the research division of the Aeronautics Branch, Department of Commerce. In recent months improvements have been made in equipment for use with the system of radio range beacons which the department is installing on the airways. Since a beginning has been made in the installation of beacons of the type which operate a visual indicator, a greater need has been felt for an automatic volume control on the receiving set used aboard the airplanes. Such a device has been developed at the bureau. It relieves the pilot entirely of manipulation in the use of the visual indicator of the beacon signals. It can be used to advantage also in receiving aural-type beacon signals. Another application is in connection with the runway localizing beacon for use either at airports or as part of the system of blind-landing aids which is being developed at the bureau. In connection with the automatic volume control, a deflection instrument is used which serves as an approximate distance indicator. Recent experiments have also added a means of indicating when the airplane is directly over the beacon transmitter, so that the landing field location is thus conveniently and directly indicated to the pilot.

Another device developed at the bureau to facilitate the use of the visual-type range beacon is the "deviometer." By its use a pilot can follow any chosen course, within limits, on either side of the equi-signal line for which the beacon transmitter is adjusted. It is a shunting arrangement which varies the relative current in the coils actuating the two reeds of the reed indicator, and a pointer indicates the number of degrees off the equi-signal line for which the deviometer is set. The device has been found useful in experimental flight tests. The bureau recently furnished one to an air transport company for service tests.

As part of the aeronautical radio work at the bureau special attention has been devoted to receiving sets. For receiving both telephone messages and beacon signals aboard an airplane, receiving sets of special design must be employed. They must be so designed as to function under particular conditions of vibration, local interference, small input voltage, high output level required, and special audio-frequency requirements. The basic designs for such sets have been developed at the bureau. It also keeps in touch with commercial developments in aircraft radio receivers by means of laboratory measurements and experimental trials on an airplane. Satisfactory receiving sets are now found to be available commercially.

SHIPPEE-JOHNSON PERUVIAN EXPEDITION

THE Shippee-Johnson Peruvian Expedition will sail from New York on December 5 to carry out, with the endorsement of the American Geographical Society, a program of aerial mapping in various parts of Peru. The expedition is equipped with two Bellanca cabin monoplanes, one of which will be used for photographic work and the other for transporting supplies. The photographic plane in addition to being equipped with the most up-to-date and efficient of photographic apparatus has a supercharged 300 horse-power motor which will make it possible to rise to altitudes up to 28,000 feet for photographic work in the Maritime Cordillera of the Andes.

The primary purpose of the expedition is to map from the air and study and photograph on the ground the little known agricultural communities on the floor of the deep gorge of the Colca River some seventy miles north of Arequipa. The Chimú Valley, the site of Chan-Chan, the capital of the kingdom of the Great Chimú, whom the Inca conquered shortly before the Spanish conquest, will also be photographed from the air and an attempt will be made to discover whether aerial mapping in the heavily forested eastern valleys of the Andes and the Amazon lowland is feasible.

Lieutenant George R. Johnson, co-leader and photographer of the expedition, served as chief photographer of the Peruvian naval air force during 1928 and 1929, and during that time made a remarkable series of aerial photographs of Peru, a selected group of which the American Geographical Society has just published as full-page illustrations (8½ by 6½ inches) in a book entitled "Peru from the Air."

SCIENTIFIC NOTES AND NEWS

THE gold medal of the Radiological Society of North America has been awarded to Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology.

THE Council of the Royal College of Surgeons has conferred the honorary fellowship of the college on Dr. Banting, of the University of Toronto, the discoverer of insulin. Lord Moynihan pointed out, according to a statement in the London *Times*, that Dr. Banting's discovery of insulin was the first piece of important scientific research in the realm of medicine contributed by the British Dominions. The college accords him the recognition of surgeons of a piece of scientific work of a physiological character bearing on the practice of surgery, though in itself something entirely outside the practice of surgery.

AT the monthly meeting of the American Geographical Society on November 26, the David Livingstone Centenary Medal for 1930 was presented to Dr. Laurence M. Gould for his explorations in the Antarctic.

THE George Robert White Medal of the Massachusetts Horticultural Society has been awarded to Dr. David Fairchild, botanist and explorer, since 1906 in charge of the office of foreign plant introduction of the U. S. Department of Agriculture.

DR. EMILE F. HOLMAN, professor of surgery at Stanford University, has been awarded the Samuel D. Gross prize for his research on abnormal arteriovenous communication.

AT a meeting of the Geological Society of London on November 5, Professor P. Lemoine, Paris, and Professor G. A. F. Molengraaff, Delft, were elected foreign members. Professor R. S. Bassler, U. S. National Museum, Washington; Professor O. Mügge, Göttingen; Dr. D. I. Mushketov, Leningrad; Madame M. Pavlov, Moscow; Professor P. D. Quensel, Stockholm, and Professor E. Stensiö, Stockholm, were elected foreign correspondents.

THE *British Medical Journal* calls attention to the issue of the *Wiener medizinische Wochenschrift* for November 1, which is dedicated to the Vienna pediatrist, Professor Hochsinger, on the occasion of his seventieth birthday, and which contains articles dealing exclusively with diseases of children.

THE title of emeritus professor of electrical engineering in the University of London has been conferred on Professor Ernest Wilson, on his retirement from the university chair of electrical engineering at King's College.

DR. E. H. VOLWILER, director of research of the Abbott Laboratories, North Chicago, has been elected a director of the organization into which the Abbott laboratories and Swan-Myers were recently merged.

DR. STEFAN ANSBACHER, physiological chemist, formerly of the institute of pathology of the University of Geneva, has joined the laboratory staff of the South Carolina Food Research Commission at Charleston.

PROFESSOR GUSTAVO PITTALUGA, director of the laboratory of parasitology at Madrid, has been named director of the Spanish National School of Hygiene.

AT the annual meeting of the American Society of Agronomy, held in Washington on November 20 and 21, the following officers were elected for the ensuing year: *President*, Dean W. W. Burr, University of Nebraska, Lincoln; *Vice-presidents*, Dr. A. B. Beaumont, Massachusetts Agricultural College, Amherst; Dr. S. A. Waksman, New Jersey Agricultural Experiment Station; Professor George Stewart, U. S. Forest Service, Ogden, Utah, and R. I. Throckmorton, Kansas State Agricultural College, Manhattan; *Editor*, J. D. Luckett, Agricultural Experiment Station, Geneva, New York; *Secretary-treasurer*, P. E. Brown, Iowa State College, Ames. Three members of the society were elected fellows. These were: President F. S. Harris, Brigham Young University, Provo, Utah; Dr. James A. Bizzell, Cornell University, and Dr. Walter P. Kelley, University of California. The winners of the Chilean Nitrate of Soda Nitrogen Research Award, sponsored by the American Society of Agronomy, were: Luther G. Willis, of the North Carolina Agricultural Experiment Station; James K. Wilson, of Cornell University, and Joshua J. Skinner, of the Bureau of Chemistry and Soils.

PROFESSOR S. C. BROOKS has been granted a half year's leave of absence from the University of California and will continue his experiments at the Stazione Zoologica, Naples. He will occupy the Woods Hole-Columbia Table there. Dr. Matilda Moldenhauer Brooks has been given a grant from the National Research Council to enable her to continue her oxidation-reduction studies at Naples and will occupy the Woman's Table of the Association to Aid Scientific Work by Women. They will sail from New York on December 16 and will return to Berkeley *via* Japan in August, 1931.

DR. KARL LANDSTEINER, of the Rockefeller Institute for Medical Research, who was recently awarded the Nobel prize in medicine, sailed for Europe on November 25 in order to receive the medal at Stockholm.

DR. ROBERT A. MILLIKAN, of the California Insti-

tute of Technology, will give the Proctor Foundation Lecture at the Brooklyn Institute of Arts and Sciences at the Academy of Music, on Saturday evening, December 13. His subject will be "Exploring the Universe."

DR. EDWIN P. HUBBLE, of the Mount Wilson Observatory, will lecture at the Carnegie Institution of Washington on December 10. The title of the lecture is "The Exploration of Space."

DR. J. B. JOHNSON, research physicist at the Bell Telephone Laboratories, New York, lectured on "The Cathode Ray Oscillograph" on December 4, before the Franklin Institute, Philadelphia.

DR. DEXTER S. KIMBALL, dean of the College of Engineering at Cornell University, lectured at the University of California on December 2 and 4, on "Economic Tendencies in Industry."

DR. B. H. HIBBARD, professor of agricultural economics and head of that department in the University of Wisconsin, will lecture for four weeks at the summer session of the Kansas Agricultural College at Manhattan.

AN illustrated lecture course on astronomy will be given during the winter, both at Pasadena and Los Angeles, under the auspices of the Astronomical Society of the Pacific and the Mount Wilson Observatory. The subjects and lecturers are as follows: "What the Stars are Made of," Dr. Arthur S. King, Mount Wilson Observatory; "Taking the Census in the Solar System," Dr. Seth B. Nicholson, Mount Wilson Observatory; "Comets and Asteroids," Dr. William F. Meyer, president, Astronomical Society of the Pacific; "Celestial Laboratories," Dr. Theodore Dunham, Jr., Mount Wilson Observatory; "The Exploration of Space," Dr. Edwin P. Hubble, Mount Wilson Observatory.

DR. CHARLES F. SWINGLE, Bureau of Plant Industry, U. S. Department of Agriculture, delivered on November 15 a lecture on "Hunting Plants in Madagascar" at the Royal Canadian Institute.

THE Henry Sidgwick Memorial Lecture at Newnham College, Cambridge, was given by Professor A. V. Hill, professor of physiology in the University of London, on November 22. The title of the lecture was "Biology in Education."

Nature reports that the third Liversidge lecture of the British Chemical Society, which was to have been delivered by Professor H. B. Dixon, will be given on December 11 by Professor W. A. Bone, at the Imperial College of Science and Technology, South Kensington. Professor Bone will take as his subject, "Fifty Years' Experimental Research upon the Influence of Steam on the Combustion of Carbonic Oxide (1880–1930)."

A SERIES of lectures is being given at the Institute of the History of Medicine, Johns Hopkins University School of Medicine, by Sir D'Arcy Power, England, honorary librarian of the Royal College of Surgeons. The subjects of the lectures are: "Essentials of Medical Biography," "Medical Bibliography," "The Meals of Our Ancestors," "Aristotle's Masterpiece," "Medical Iconography" and "The Growth of a Hospital."

THE second annual meeting of the American Association of Physical Anthropologists will be held on December 29 to 31, in Cleveland, in affiliation with Section H of the American Association for the Advancement of Science and with the American Anthropological Association. The society's sessions will be held in the department of anatomy of Western Reserve University. A joint meeting and a joint dinner will be held with Section H of the American Association for the Advancement of Science and with the American Anthropological Association. For members desiring to make reservations of rooms, the Hotel Winton is suggested.

THE Central Society for Clinical Research held its third annual meeting at the Research and Educational Hospital of the College of Medicine, University of Illinois, on November 21. About two hundred members attended the meeting. The officers elected for the ensuing year are: *President,* Dr. Louis Leiter, and *Secretary,* Dr. Lawrence D. Thompson.

THE first regular meeting of the American Geographical Society for the season 1930–1931 was held on November 25, at the Engineering Societies Building, New York City, President John H. Finley in the chair. Laurence Gould, of the University of Michigan, addressed the society on his Antarctic field work of 1928–1930. Dr. Gould was the geologist and geographer, as well as the second-in-command, of the Byrd Antarctic Expedition. During the expedition he made two independent trips, one by airplane, to the newly discovered Rockefeller Mountains, 150 miles east of Little America, and the other by dog sledge 440 miles south from Little America to the mountains at the border of the South Polar Plateau. Of these border mountains, for a distance of 250 miles, the first adequate survey was made.

THE fifty-first annual meeting of the American Society of Mechanical Engineers opened on December 1. The ninth national exposition of power and mechanical engineering in which four hundred exhibitors have taken space is being held in connection with the meeting. The engineering departments of

Princeton, Stevens Institute, the Massachusetts Institute of Technology, Rensselaer, Cornell and the University of Pennsylvania are among those to be represented at the exhibit. There will be a special exhibition of the works of the late Dr. Elmer A. Sperry, past president of the society, at the museum, as well as motion pictures and a sound cartoon explaining the production and exhibition of talking pictures.

THE *British Medical Journal* states that on the occasion of its tenth annual meeting the German Society for Diseases of the Digestive System and Metabolism has founded a Boas prize of the value of 1,000 marks. The subject is the bacterial and non-bacterial origin of diseases of the pancreas. Candidates should send in their essays by April 1, 1931, to the general secretary, Professor R. von den Velden, 30, Bambuga Strasse, Berlin, from whom further information can be obtained.

COLUMBIA UNIVERSITY will receive $173,232 under the will of Miss Euretta J. Schlegel, who died in Brooklyn on December 4, 1929. The legacy is provided for the purpose of establishing fellowships "for the study of letters at Oxford or Cambridge."

THROUGH error in transcription the Central Chemical Company of Chicago instead of the Central Scientific Company was credited in a recent issue of SCIENCE with endowing a national chemical fellowship at the Johns Hopkins University.

UNDER the will of the late Lord Brotherton, who died on October 21, the University of Leeds will receive £100,000 for general purposes, and in addition a gift to the university library of his collection of books, with an endowment for upkeep.

A REVISION of the graphical symbols used in radio communication has been prepared by a technical committee under the auspices of the American Standards Association and is now being considered by the Institute of Radio Engineers for submittal to the association for approval. The purpose of the revision is to eliminate any possible confusion between radio symbols and the symbols used in other branches of engineering. A general committee on scientific and engineering symbols and abbreviations, working under the American Standards Association procedure, has already completed national standard symbols for hydraulics, for heat and thermodynamics, for photometry and illumination, for aeronautics, for mathematics, for electrical quantities, for telephone and telegraph use, and for navigation and topography. The American Association for the Advancement of Science, the American Institute of Electrical Engineers, the American Society of Civil Engineers, and the American Society of Mechanical Engineers are joint sponsors for the work of the technical committee which prepared the symbols.

THE *Journal* of the American Medical Association reports that the board of health for the University of Iowa, authorized by President Walter Jessup, was recently organized and its divisional work inaugurated with headquarters at the student out-patient service offices. The personnel includes Dr. Henry S. Houghton, professor and dean of the college of medicine, chairman; Dr. Fred M. Smith, professor and head of the department of theory and practice of medicine; Dr. Milford E. Barnes, professor and head of the department of hygiene and preventive medicine, secretary, and Dr. Carl E. Seashore, head of the department of psychology and the graduate college; Mr. Robert E. Rienow, dean of men; Miss Elizabeth Halsey, professor and head of the department of physical education for women, and Dr. Edward H. Lauer, professor and director of the division of physical education. With the approval of Dr. Daniel C. Steelsmith, state commissioner of health, the university board will enforce regulations of local health officers and remove possibilities of menace to health arising from the existence of the hitherto "no man's land" in the form of state owned properties. The activities of the new board will include the inspection division, under the direction of Mr. Jack J. Hinman, Jr., assistant professor of sanitation and chief of the water laboratory which will carry out the sanitary inspection of all buildings under the direction of the quasi control of the university and all water, milk and food supplies and swimming pools. The communicable disease section, under Dr. Carl F. Jordan, assistant professor of hygiene and preventive medicine, will investigate and act on all reportable and communicable diseases within the university health district; those cases involving extramural action will have close cooperation with the local health authorities. The life extension division, under Dr. Chester I. Miller, chief of the student out-patient department, and Drs. L. B. Hanson and Grace E. Williams, examiners for men and women, respectively, will handle students, nurses and employees. The health examinations now required of all freshmen will be extended to include all incoming registrants and all prospective graduates during their final year. The student out-patient department will be supervised by Dr. Miller and will care for student illnesses, and those in need of additional service are referred to the hospital, for which a nominal charge is made.

ARRANGEMENTS have been made by the Department of Conservation and Development for the first large-scale planting of Asiatic chestnut trees in North Carolina by federal and state officials in an effort to replace the native tree destroyed by blight. Five thou-

sand seedlings, which range from two to three years in age, have been acclimatized at the State Forest Nursery near Clayton. They will be planted almost exclusively on publicly owned lands that their growth and condition may be checked closely. Settings will be made in orchard formation to assure a future supply of nuts if the trees thrive in their new environment.

DISCUSSION

CONSIDERATIONS LEADING TO THE VIEW THAT PELLAGRA IS AN IRON-DEFICIENCY DISEASE

THERE are so many facts recorded in the literature which tend to support the idea that iron deficiency occurs in pellagra that it seems curious that no one has suggested that the etiology of pellagra is in some way related to iron deficiency. At least the writer has not found such a reference.

Pellagra is practically unknown in very young infants (first year or two). In this connection it is interesting to note that children, puppies, kittens and rabbits are born with an iron concentration of about three times that found in adults. It is worthy of note that the young just mentioned get their first nourishment from milk which has a low iron content, while guinea-pigs, which feed like adults as soon as born, have no higher iron concentration than full-grown animals.

It is recorded that in the investigations of the Thompson-McFadden Pellagra Commission the disease was found to be more prevalent in women than in men—and particularly within the age limits of 19 to 44 years. Between these ages the menstrual cycle in woman causes her to lose 250 cc or more of blood each 28 days. Calculating the hemoglobin content of blood as 10 per cent. and iron as 0.335 per cent. of hemoglobin, the daily loss of iron by this route alone is 3.00 mg. Sherman estimates that such daily loss may average 3.0 mg. Unless the food eaten contains abundant iron this loss, in women certainly, operates to cause a depletion of the amount of iron in the body. Pellagra, in the United States, occurs almost wholly among the rural population of the Southern states, and is found chiefly among those whose economic status forces them to subsist upon a diet made up largely of corn bread and syrup—a diet low in iron. The low iron content of the diet of the women in the rural districts in the South, coupled with the regular losses of iron during menstruation, therefore, are in harmony with the view that the higher incidence of pellagra in women between the ages of 19 and 44 years is related to an iron deficiency. In connection with the foregoing it is also interesting to note that the symptoms of pellagra are usually ameliorated during pregnancy.

Largely as the result of the work of Goldberger and his associates it is generally believed that the heat-stable portion of vitamin B (called the P-P factor or vitamin G—after Goldberger) protects against pellagra. This work of Goldberger has made less of an impression upon clinicians and laboratory workers in the South who are in actual contact with the disease than might be inferred from its ready acceptance in standard texts to-day. Assuming, however, that there is such a "vitamin," its exceptional stability towards heat and its concentration by absorption on kaolin lend themselves suggestively to the idea that the active agent may, indeed, be iron.

Goldberger and his associates adopted the working hypothesis that black-tongue of dogs is the analogue of pellagra in man, and they found that diets which are effective in preventing pellagra in man are also effective in preventing black-tongue of dogs—and the same is said of the curative effects of those diets. Examination of the protocols published by Goldberger reveals the fact that those diets which prevented or cured black-tongue in dogs are just those to which had been added "syrup iodid of iron U.S.P.," and those diets which when fed to dogs produced black-tongue or failed to cure the disease are those to which no iron had been added. Apparently the iron was not added to or withheld from those diets with any intent to affect the balance of the element, because the footnote explains that it was added to "improve the mineral composition of the diet." They make no further mention of iron.

Further, it may be said that the foods which are supposed to contain liberal quantities of vitamin G (beef, liver, egg yolk, yeast) are all iron-containing foods (some of them being among those containing more iron than any other known biological product), while the pellagra-producing diet of poor farmers of the South (molasses and corn bread) is extremely poor in iron.

The anemia which is a very frequent concomitant of pellagra may be yet another finger pointing to an iron deficiency in pellagra.

The achlorhydria of pellagra would certainly promote a greater than normal alkalinity in the region of the duodenum, and the lessened solubility of iron salts in an alkaline medium would hinder their absorption—for it is known that it is there that iron is almost wholly absorbed.[1]

[1] A. B. Macallum, "On the Absorption of Iron in the Animal Body," *Journal of Physiology*, 16: 268, 1894.

Kollath,[2] working with rats, found that the administration of alkaline hematin served to prevent the symptoms which ordinarily supervene when the P–P factor or "vitamin G" is withheld from the diet. The above reasoning leads one to question whether or not it was the iron, so given, that conferred the benefit.

While none of the considerations here outlined prove that pellagra is an iron-deficiency disease, there is much plausibility to the view, and the writer has adopted the working hypothesis that pellagra is an iron-deficiency disease, and has set out to prove or disprove the thesis.

During the past summer the results of iron therapy have been studied in 51 cases of human pellagra. In severe cases, the iron was administered intravenously, and in milder cases it was given orally.

Although the clinical course of this disease is so variable that it is difficult to make a reliable prognosis in any single case, the results obtained are of a very encouraging nature. A more detailed report of these clinical studies will be published elsewhere.

Our studies included one series of dogs with blacktongue—believed by some to be the canine analogue of human pellagra. The animals were maintained on the Chittenden-Underhill diet of peas, cracker meal and cotton-seed oil. The dietary deficiency disease first described by the above-mentioned authors was produced in all its severity, and when the dogs in this condition received iron by the intravenous route, without any other alteration in the régime, they were restored to a normal appearance as judged by the disappearance of characteristic symptoms, return of appetite and an increase in body weight. These experiments are being repeated, extended and amplified, and will be reported in due course.

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[2] W. Kollath, "Water-soluble Vitamins and Their Relation to Each Other" (abstract), *Chemical Abstracts*, 24: 1887, 1930.

SUPPLEMENTAL NOTE REGARDING MOSQUITO VECTORS OF EXPERIMENTAL YELLOW FEVER

IN a recent issue of this journal, the writer[1] summarized, in brief, attempts of several investigators to transmit experimental yellow fever through mosquitoes of various species. Shortly afterward abstracts of the work of Dr. Shüffner and his coworkers with *Aedes* (*Stegomyia*) *albopictus*[2] and of de Vogel with *"Stegomyia scutellaris"*[3] came to hand. As these mosquitoes are important semidomestic insects in the Far East, it seems of importance to call attention to these additional data. In biting experiments, the former authors report one fatal infection in ten rhesus monkeys tested, and de Vogel obtained only non-fatal infections in six monkeys, although a blood subinoculation from one of the latter produced death in another animal.

A point in taxonomy is raised in connection with the above two mosquitoes. On the basis of misidentified specimens, Theobald sank *A. scutellaris* into synonymy with *A. albopictus*. Both Edwards and Barraud have since corrected this mistake, placing *A. scutellaris* Walk. nec Theo. as a synonym of *A. variegatus* Bigot. Walker's type came from the Dutch East Indies, and the present distribution of *A. variegatus* is given as "Christmas Island, South of Java and many Pacific islands." *A. albopictus* occurs throughout the oriental region.

One would be inclined to conclude on the basis of the abstracts that two distinct species of mosquitoes were used by the above investigators, but I am informed that in his original article de Vogel treats the *"Stegomyia scutellaris"* with which he was working as synonymous with *A. albopictus*.

While the results of transmission experiments with *A. albopictus* do not indicate this species to be as favorable to the virus as the Javanese *A. aegypti*, which were also tested, or the West African *stegomyiae*, in our experience, yet incrimination of this ubiquitous oriental mosquito constitutes information of high potential value in prophylactic measures.

Taeniorhynchus (*Mansonioides*) *africanus* and *Aedes vittatus* are two important species incriminated by the writer in experimental yellow fever transmission which also occur in the Far East. With *A. aegypti*, the common host of that disease, and *T. uniformis*, an untested but very close relative to *T. africanus* which should be equally capable of acting as a host, also widely distributed in that region, one dreads to contemplate the appalling situation that would develop should the virus of yellow fever ever become established in East Africa and thence be spread into the vast, densely populated Orient.[4]

CORNELIUS B. PHILIP

HAMILTON, MONTANA

[1] C. B. Philip, SCIENCE, 71: 614–615, June 13, 1930.

[2] J. E. Dinger, W. A. P. Schüffner, E. P. Snidjers and N. H. Swellengrebel, *Nederl. Tijdschr. v. Geneesk.*, December, 1929, No. 51, pp. 5982–91.

[3] W. de Vogel, *Bull. Office Internat. d'Hyg. Publique*, February, 1930, 22: 282–286. Abstracts in *Trop. Dis. Bull.*, 27: 486–487, June, 1930.

[4] The writer is indebted to Dr. C. E. Mickel and Mr. W. B. Owen, of the University of Minnesota, and to Dr. H. W. Kumm, of the Rockefeller Foundation, for references in connection with the systematic points referred to above.

ANOSMA OR "SQUEEZE-UPS"

THE Sunset Crater Lava flow lies fifteen miles northeast of Flagstaff, Arizona, and presents the most recent evidences of volcanic action in the San Francisco Mountain area. The surface of the flow bears curious fissures. These fissures are filled with basaltic masses which have been given the name of anosma[1] or "squeeze-ups."[2]

The Sunset Lava flow, called by Robinson, 1913, the Bonito flow,[3] seems to arise from a fissure at the northwest base of Sunset Crater. From the point of origin now marked by a line of fumeroles, the basalt flowed west and north spreading fanlike over an intercone basin, a basin in which the natural drainage has been blocked by cinder cones. That the flow had two phases is very evident. During the primary phase the flow extended about a mile from the vent. Following this flow an ash fall covered the surface. From the fringes of the primary flow a series of secondary flows poured out into the basin. These flows were probably contemporaneous, as they have coalesced to form an apron in some places a few hundred feet wide and in others almost a mile. The scoriaceous surfaces of the secondary flows are free from volcanic ash. We can, therefore, conclude that an ash fall occurred in the interval of time between the primary and the secondary flows.

The primary lava flow is cut by a fissure. This fissure extends from near the base of Sunset Crater a mile and a quarter northwest to the edge of the primary flow and varies in width from a few feet to seventy-five feet. Through this fissure basalt in a plastic condition has been squeezed. The sides of this basalt tongue are grooved, conforming to the walls of the fissure, and slickenside[4] surfaces are usually present. In the wider parts of this fissure, the more plastic inner layers of the mass seem to have slid over the outer less plastic plates so that we find a series of vertical layers pushed into the air.

That the mass was plastic, like stiff clay, is evident from the rough surface of the sides of the plates that have been in contact with the walls. Small lunar-shaped sharp ridges something less than a quarter of an inch high in parallel series, with an axis perpendicular to the direction of the up-thrust, are observed on the surface of the plates, a condition often seen in the molding of bricks. Again, the thin plates of basalt by the effect of gravity have arched over as they were pressed up into the air. All these facts testify to the plastic nature of the basalt.

Besides the long squeeze-up, mentioned above, others are known, many of them less than two hundred feet long, and one is over one hundred and twenty feet wide. All these squeeze-ups are located on or near the edge of the primary lava flow and form points of origin of secondary flows. One fissure but two feet wide contains a squeeze-up the top of which does not reach the surface.

If we trace the big squeeze-up to its northwest end we are led to a tumbled mass of lava where squeeze-ups radiate in all directions. This wild weird place, which we have called the "Mother of Squeeze-Ups," forms the source of one of the larger peripheral secondary lava flows. Here, the scoriaceous lava can be seen to have oozed out of the crack between the squeeze-up and the primary flow.

The remains of numerous fumeroles dot the surface of the primary flow but are absent on the surface of the secondary flows. Silicious deposits and the oxidation of the iron in the basalt on the surface of the primary flow tell of the action of hot gases. These observations indicate that the lava beneath the primary flow was long in cooling. The squeeze-ups, therefore, seem to have some relation to a deep mass of basalt slowly cooling but still connected with the active vent.

Dr. T. A. Jaggar, of the Hawaiian Volcano Observatory, in a letter, suggests that this condition may be similar to "Schollendomes" in Hawaii. He states that often a lava flat is swollen up at the front of a flow. Lifting the shell is easier than pushing it out. The paste inside breaks through the roof of the dome so formed. The inside is much like a laccolith. In Hawaii, however, the lava is never stiff enough to stand up in arches.

Except at the edge of the primary Sunset lava flow the lava seems to be in hydrostatic equilibrium. In other words the average height of the squeeze-up plates are lower than the surface of the primary flow, although individual thin plates may extend ten feet or more into the air over the level of the flow.

Anosma or squeeze-ups seem to be unique. Good examples are abundant on the primary lava flow from the northwest base of Sunset Crater.

HAROLD S. COLTON
CHARLES F. PARK, JR.
MUSEUM OF NORTHERN ARIZONA

[1] Name suggested by Dr. H. Lamar Crosby, of the University of Pennsylvania. A brand new name derived from the Greek, meaning something pushed up.

[2] Suggested by W. M. Davis, Harvard University.

[3] H. H. Robinson, "San Francisco Mountain Volcanic Field," U. S. G. S. Prof. Paper No. 79, 1913.

[4] It may not be literally correct to refer to "slickensides" in a plastic medium but the writers know no other word.

MOSQUITOES VERSUS CULICIDAE

How many readers of SCIENCE are accustomed to swatting culicids? A very small number of us may delve academically into the habits of the Culicidae;

all of us at one time or another have been acutely concerned in the "control" of mosquitoes. As a member of the latter class, most of whose members must confess to academic delving in some other field, the writer wonders if the value of G. A. Mail's recent note in SCIENCE[1] would not have been increased many fold if *Aedes campestris* had been presented as a mosquito rather than as a culicid.

The writer, who knows and probably overuses a lot of long names in his own branch of study, was able to deduce from the origin of the above-mentioned note in an entomology department the fact that *Aedes campestris* is some species of insect, but a dictionary was essential to further appreciation of an otherwise interesting contribution. The very brevity of the statement suggests that it was addressed to a larger group of readers than those who readily recognize Culicidae as the family name of the mosquitoes. Should not the author, or the editor, have given those of us who scan SCIENCE in search of adult education more initial encouragement by featuring "Mosquito" rather than "Culicidae" in the parenthetic title?

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SPECIAL CORRESPONDENCE

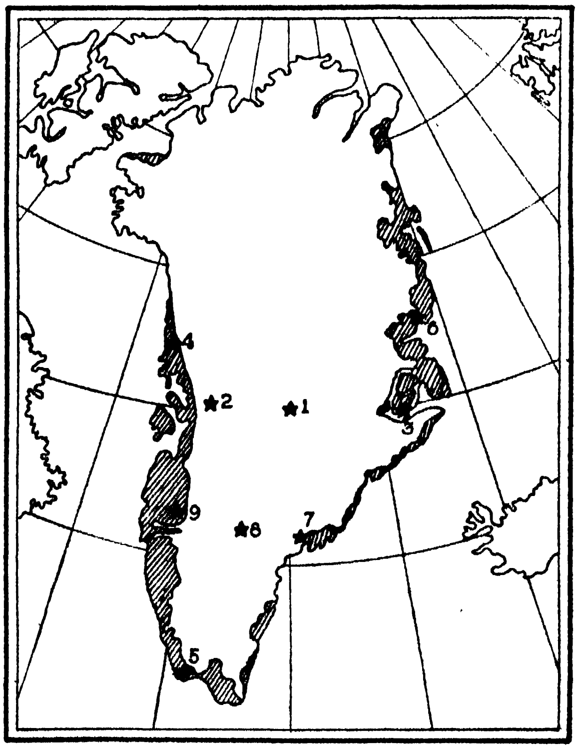
AEROLOGICAL STATIONS IN GREENLAND 1930–1931

FOR the first time a number of aerological stations each set up for the period of a year are now operating in Greenland. The outline map of Fig. 1 shows the approximate positions of the eight stations (1–8). Six of them are now, it is believed, sending up pilot balloons on all fair days.

First in importance are the stations of the German Expedition under Dr. Alfred Wegener (1–3), the veteran Greenland explorer and meteorologist, following upon his important preliminary studies carried out on the west coast in 1929.[1]

Recent radio reports published in the New York *Times* show that his station near the central axis of the inland-ice about 250 miles distant from either coast and about 10,000 feet above the sea (1) has already for a good many weeks been functioning under Dr. J. Georgi. The station on but near the western margin of the ice (2) is also reported to be in operation. Wegener's eastern station under Dr. Kopp was to have left Copenhagen in July and to be located on Scoresby Sound near sea-level and as near as possible to the inland-ice. All these German stations are near latitude 71°.

The University of Michigan stations (4 and 5) are on the west coast about equally distant north and south from the Mount Evans aerological station (9) which was operated from July, 1927, to July, 1929, but is now closed. Letters received from William Carlson in charge of the northern station indicate that he was erecting his observing station on the summit of a small island 400 feet above sea-level in latitude 72° 50′ and only two miles distant from the inland-ice. Balloon ascents were to begin on September 1. Evans S. Schmeling, of the southern station, is at the settlement of Ivigtut in extreme south Greenland (latitude 61°). Letters from him dated in late August indicate that he was to begin regular balloon ascensions on September 1.



The British Arctic Air Route Expedition, according to radio reports from the New York *Times*, has now for a number of weeks been operating its station on the inland-ice near the central axis (8) and thus in a position similar to Wegener's station 1; as well as a station at the expedition's base on the Sermilikfjord near the Danish settlement of Angmagssalik (7) in latitude 66°.

[1] G. A. Mail, "Viability in Eggs of *Aedes campestris* Dyar and Knab (Culicidae)," SCIENCE, 72 (No. 1859): 170, 1930.

[1] A. Wegener, *Zeitsch. d. Gesell. f. Erdkunde z. Berlin*, 1930, nos. 3–4, pp. 81–124.

The remaining Greenland station (6) is that of a party of Norwegian hunters supplied with pilot balloons at their station of Mygbukten (Mackenzie Bay) in latitude 73°, where they are operating under the auspices of the Meteorological Institute of Oslo.

UNIVERSITY OF MICHIGAN WILLIAM H. HOBBS

SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPROXIMATE METHOD FOR DETERMINING THE SAME DEGREE OF ANESTHESIA FOR FISH

THIS method is primarily one of electrical stimulation. While it is not hair-splitting in accuracy, still it is very reliable, the criterion for this statement being the number of times the anesthetizing time for any particular fish in the same strength solution checks. The accuracy of this method, of course, depends a great deal upon the acuteness of the power of observation of the operator.

APPARATUS

Fig. 1 illustrates the apparatus used. This consists of a glass cylinder A fastened to a ring-stand by

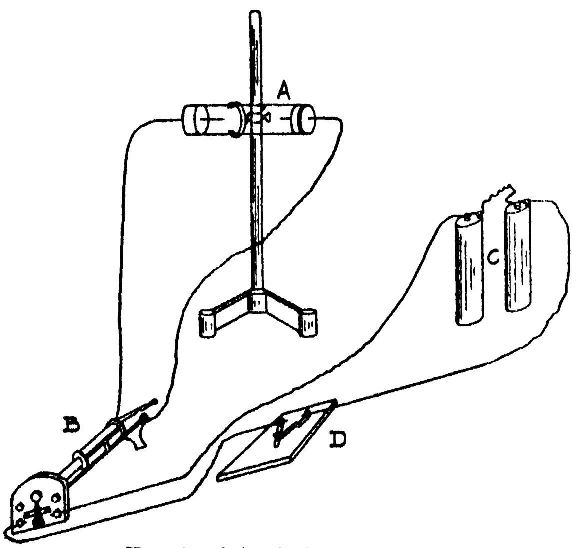


FIG. 1. Stimulating apparatus.

means of a clamp, induction coil B, two dry cells C, a simple key D and two copper stimulating electrodes leading from the secondary coil into the glass cylinder A. Cylinder A is sealed by two rubber stoppers through which the electrodes protrude. The stimulus consists of tetanic induced current from an inductorium receiving its current from the two dry cells. In order to insure the same strength of current (which has been previously determined to be the optimum stimulus), the secondary coil must always remain at the same position in the inductorium. The dry cells should also be tested at regular intervals with the voltmeter. The electrodes leading into the glass cylinder A should be cleaned thoroughly every time the apparatus is put into use. The interrupter points of the inductorium should be readjusted in order to maintain the pitch of the vibrator. The circuit is established by closing the simple key D.

TECHNIQUE

Cylinder A is placed in a vertical position and filled about four fifths full with the solution to be tested. The same number of cubic centimeters should be used each time. The fish is introduced immediately into the cylinder, at which time a stop-clock is started. The removable stopper is replaced and the glass cylinder returned to the horizontal position. After a second or so, depending upon the strength of solution, the fish is stimulated at intervals by pecking on the simple key D until it gradually becomes less and less irritable. Finally the response obtained will change from an active response of the whole fish to local muscular contractions of the tail at which point appear also, to a close observer, tremors comparable to "ether tremors" as reported by Hewitt.[1] It is a mistake to continue stimulating until no response is received, because in the majority of cases where this is done the fish will not recover.

It can then be seen by the above brief description that the success of this method depends upon (1) keeping the strength of current as nearly constant as possible; (2) the ability of the operator to recognize the transition from response of the fish as a unit to local contraction of the tail muscles, and (3) the recognition of the accompanying tremors.

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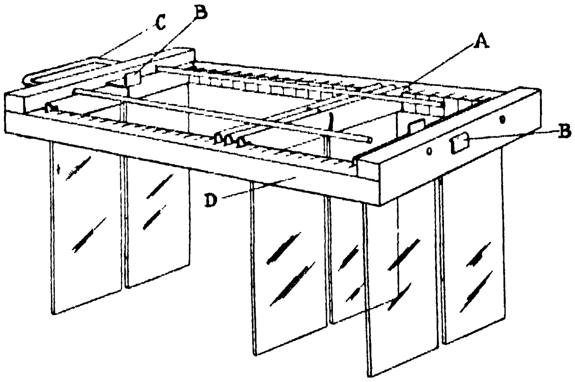
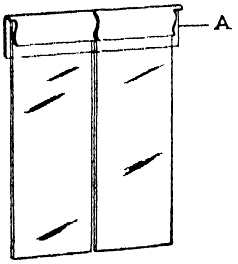
A NEW STAINING RACK FOR MICRO-SLIDES

THE rack here described and illustrated consists of a metal frame (D) appropriately slotted to receive a number of metal clips (A) of a particular design, which hold the micro-slides. The frame and clips are made of non-corrosive metal. However, no part of the rack, neither frame nor clips, is immersed in the staining bath. The clips are made of thin strips of an elastic metal folded lengthwise, the fold viewed on end having somewhat the bend of the traditional shepherd's crook. One side of the fold is wider and longer than the other; the projecting ends of this side, the upper borders of which are bent over in the

[1] Hewitt, "Anesthetics," p. 363, 1912.

direction of the fold, fit into the slots in the frame and hold the clips in place. The shorter fold of the clip is cut in half by a vertical slit. The clips are designed to hold the slides by one end only. Each clip will hold two slides each one inch wide, or one wider slide up to two inches in width. When two one-inch slides are in a clip, either can be removed without disturbing the other. In use, the two end clips and their slides are made to serve as legs, or supports, for the rack by pushing in the catch (B) at each end of the frame; the other clips with their slides are then dropped in place. The rack and clips are supported by these legs above the level of the staining bath. Every clip in the frame is held inde-





pendently of the others and apart from the two end clips serving as legs, as few or as many as may be desired can be put in up to the capacity of the rack. Any clip with its slides, except the end ones, can be readily removed for examination at any stage of the staining process without disturbing the others. If desired, all the clips in the frame can be secured against falling out when the rack is in any position by sliding the U-shaped rod (C) into the holes in the ends of the frame.

Compared with the ordinary basket-like type of rack in which the rack and slides are more or less completely submerged in the staining bath, this new rack, in contrast, is not immersed at all; only the free portions of the slides are immersed and then not more than deep enough to submerge the specimens on them. On taking the slides out of the bath, the quantity of fluid adhering and withdrawn with them is small in comparison with that taken out by the ordinary style rack. A noticeable economy is achieved in the quantity of stain used, and at the same time the quantity carried over into any succeeding bath, contaminating it more or less, is reduced to the minimum practicable in quantity staining.

When compared with other staining racks in which the slides are held at one end but secured by a screw this new rack is decidedly the more convenient to work with; the slides can be taken out and put back without disturbing the others and in a fraction of the time required to unscrew and again tighten the screw type of holder.

Another advantage of this new rack is that it will hold two-inch slides as easily as one-inch ones, and both widths of slides may be stained at one and the same time.

The staining rack here described is not on the market; it was made as an experiment and has been found the most satisfactory rack for quantity staining with which the subscribed is familiar. The size of the rack is approximately 6 inches long by 2⅞ inches wide, and holds 62 one-inch slides or 31 two-inch slides.

This particular size was selected because it fitted nicely in a covered dish that was obtainable in the market.

Made as a special job, the cost was quite high, but should the design appeal to microscopists it could be supplied at a less cost. The Arthur H. Thomas Company, of Philadelphia, Pennsylvania, had the rack made for me.

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SPECIAL ARTICLES

THE LETHAL DOSE OF ULTRA-VIOLET LIGHT FOR BROOK TROUT (SALVELINUS FONTINALIS)

Many chemical agents have been studied by fish culturists in attempts to check the epidemics of parasitic diseases that frequently cause severe financial losses in the best trout hatcheries. Although some of these agents are quite effective in checking fungus growths, they are often difficult to apply since the fish must be removed from the troughs and the troughs must be sterilized separately.

Ultra-violet light affords new opportunities for the control of fish diseases. It is unique in providing a means for the simultaneous treatment of both the fish and the water in which it swims. Since no experiments have been reported which deal with the ultra-violet radiation of normal fish we have summarized in the accompanying table some of our data. Before

TABLE I

THE LETHAL DOSE OF ULTRA-VIOLET RADIATION FOR BROOK TROUT

Depth of water in inches	Distance of lamp from water in inches	Time of exposure in minutes	Time between exposures in hours	No. of exposures	No. trout killed	Results
1	6	5	24	3	4	Two died after third exposure. Two more died next day.
1	12	5	24	4	1	One died fifth day—others appeared grayish as if burned.
1	6	3	24	5	10	Three dead after fourth exposure. Four more dead after fifth exposure. Rest died next day.
1	12	3	24	16	1	No deaths until tenth day. Had not appeared normal or eaten well for a few days before.
1	12	3	18	5	0	No deaths. Held for 6 days after last exposure.
3–4	12	1	24	10	0	Apparently no detrimental effect.
3–4	6	90		1	3	Very grayish in appearance when removed—two died next day, one some time later. All appeared burned.

being radiated the trout were placed in a wire cage twelve inches square. This cage contained a screen bottom and top so that the fish could be confined in a water stratum at a definite distance from the surface. Ten trout about 2 to 3 inches in length were used in each experiment. During the radiation the trout were kept in their usual habitat of flowing spring water at a temperature of 10° C.

Our table shows that trout are killed by one long period of radiation or by a series of short periods at daily intervals. It also shows that trout can withstand a certain amount of radiation without injury. This affords a zone for further experiments in attempts to destroy the parasites without injuring the fish. No reliable comparison can be made between the sensitiveness of fish and the higher animals to ultra-violet radiation since the penetration of water by ultra-violet light seems unsettled. If water is readily penetrable, trout are less sensitive to radiation than man; if the reverse is true they are probably more sensitive.

The lamp used in these experiments was the Uviarc poultry lamp which was furnished us through the courtesy of the General Electric Company.

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C. M. McCAY

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ON THE OXIDATIVE NATURE OF THE NERVE IMPULSE[1]

A YEAR or so ago I succeeded in demonstrating[2] that although nerve conduction may go on in nitrogen for some time, for which chemically bound oxidative reserves were presumably used, no excess carbon dioxide was given off as is the case in aerobic conduction. The tentative view was adopted that the initial phase of conduction, manifested by the action potential as usually recorded, was conditioned by if not caused by a union of some substance in nerve with oxygen, rather than a complete oxidation with the accompanying production of carbon dioxide. I attempted at that time to determine manometrically whether this oxygen, required for stimulation, had first to be activated or whether molecular oxygen sufficed. Owing to inadequacies in the technique, the results were only suggestive and were not published. This work was made the starting-point of a program of research aimed at a clearer elucidation of the physical chemical processes responsible for the propagation of the impulse in nerve; the purpose of the present notice is to report a few of the results thus far obtained.

For this work I have turned to the theory of Warburg as being the most promising experimentally. Warburg believes to have shown that the respiratory enzyme is an iron-containing, hemin-like substance which can be poisoned by cyanides, hydrogen sulphide and carbon monoxide. Neither Warburg nor his collaborators have ever worked on nerve, however. Hence it became our first task to see whether nerve behaves towards these poisons as does Warburg's yeast.

To be very brief, it appears that sodium cyanide may inhibit nerve respiration very completely. In dilute solutions, *e.g.*, N/1000 NaCN, the inhibition is

[1] From a paper presented at the Marine Biological Laboratory, Woods Hole, Massachusetts, on July 25, 1930, and summarized in *The Collecting Net*, 5: 145, 1930.

[2] F. O. Schmitt, *Biochem. Zeitschr.*, 213: 443, 1929.

complete only for an hour or so, thereafter wearing away to a certain residual amount. In strong solutions, *e.g.*, N/10 NaCN, the inhibition is practically constant from the first and amounts to 80 to 95 per cent. The explanation of the escape from inhibition is to be found, perhaps, in the expulsion of HCN from the inner fibers by the lactic acid as a result of the anoxemia produced since lactic acid is stronger than HCN by some six orders; the effect may also be due somewhat to a relatively slow outward diffusion of the lactic acid.

Similarly it was found that nerve respiration may be inhibited fairly completely by carbon monoxide in the dark. The constant expressing the relative affinities of the carbon monoxide and oxygen for the iron catalyst represented by the equation $n/1-n \cdot CO/O_2 = k$ was found to approximate closely to the value of 10 as was found for other cells by Warburg. Furthermore, illuminating the nerve causes a marked decrease of the carbon monoxide inhibition of resting metabolism.

By far the most striking results were obtained when the effect of carbon monoxide on the action potential was studied by means of the cathode ray oscillograph. In mixtures containing from 1 to 3 per cent. of oxygen in carbon monoxide it was found that the height of the action potential decreases progressively to extinction, this decrease being considerably faster than in a similar mixture of oxygen with nitrogen. If during this decline in carbon monoxide the nerve be illuminated by means of an arc-light, the height of the action potential rises immediately and may return to, or even exceed somewhat, the original value. It is important to note that the potential rises immediately with illumination but does not drop at once when the illumination is turned off; the return to the original extinction curve usually takes from 20 to 30 minutes. That the effect is not one of temperature rise or of photo-oxidation is shown by the fact that a companion nerve in nitrogen failing along a similar curve is quite unaffected by the illumination. There is some evidence of small rises in potential in illuminated nerves in presumably *pure* carbon monoxide; the explanation of this is at present not yet clear.

The work is not sufficiently far along to warrant any sweeping generalizations, but it seems clear that the action potential is produced by an oxidation or oxygenation of a substance or substances in nerve, and that for this purpose, activation of the oxygen by a respiratory enzyme similar to that of Warburg's is essential. Since nerves usually do not fail in pure carbon monoxide any faster than in pure nitrogen it appears that the function of the iron catalyst is chiefly to make active oxygen available to the irritable mechanism which when stimulated is then capable of producing the action potential. For the further elucidation of the rôle of the iron catalyst and of the oxidations required for the production of the action potential I am attempting to bring together two distinct lines of research: that of manometric measurement of metabolism, and that of the measurement of the electric potential of nerve. Indeed, some progress has already been made in this direction; I refer to the fact that it is now possible in our hands to obtain accurate records of the height, shape, duration, etc., of the action potential of nerves with the cathode ray oscillograph whilst measuring simultaneously their metabolism manometrically. Only by such a union of methods will the questions raised in this report be adequately answered.

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BARKER, T. V. *Systematic Crystallography.* Pp. xi + 115. 76 figures. 7/6. *The Study of Crystals.* Pp. xvi + 137. 181 figures. 8/6 net. Thomas Murby, London.

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DIRAC, P. A. M. *The Principles of Quantum Mechanics.* Pp. x + 257. Oxford University Press.

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MACCALLUM, W. G. *William Stewart Halsted, Surgeon.* Pp. xvii + 241. Illustrated. Johns Hopkins Press. $2.75.

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THE AGRICULTURAL REVOLUTION IN THE UNITED STATES—1860-1930[1]

By Professor LOUIS BERNARD SCHMIDT

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THE transformations through which the United States has been passing since 1860 are so varied, so far-reaching and so profoundly significant that the historian is justified in assigning to this period of our history a place of importance second to none of the many corresponding epochs of time in the preceding centuries. It is an era of great complexity; a challenge to the student of American development.

The importance of these changes was emphasized more than a generation ago by David A. Wells in his book on "Recent Economic Changes" published in 1889 in which appear these significant passages:

The economic changes that have occurred during the last quarter of a century—or during the present generation of living men—have unquestionably been more important and varied than during any former corresponding period of the world's history. It would seem, indeed, as if the world, during all the years since the inception of civilization, has been working up on the line of equipment for industrial effort—inventing and perfecting tools and machinery, building workshops and factories, and devising instrumentalities for the easy intercommunication of persons and thoughts, and the cheap exchange of products and services; that this equipment having at last been made ready, the work of using it has, for the first time in our day and generation, fairly begun; and also that every community, under prior or existing conditions of use and consumption, is becoming saturated, as it were, with its results. As an immediate consequence the world has never seen anything comparable to the results of the recent system of transportation by land and water; never experienced in so short a time such an expansion of all that pertains to what

[1] This paper was presented before Section L—Historical Sciences, of the American Association for the Advancement of Science, Des Moines, Iowa, December 28, 1929. The foundation of this paper is the article on "Some Significant Aspects of the Agrarian Revolution in the United States," which appeared in the *Iowa Journal of History and Politics*, 18 (No. 3): pp. 371–395, July, 1920, published by the State Historical Society of Iowa.

is called "business"; and has never before been able to accomplish so much in the way of production with a given amount of labor in a given time.

The problems which our advancing civilization is forcing upon the attention of society are, accordingly, of the utmost urgency and importance, and are already occupying the thoughts, in a greater or less degree, of every intelligent person in all civilized countries. But, in order that there may be intelligent and comprehensive discussion of the situation, and more especially that there may be wise remedial legislation for any economic or social evils that may exist, it is requisite that there should be a clear and full recognition of what has happened.

Frederick J. Turner, who has inaugurated and inspired most of the work in the economic interpretation of history which has been done in this country, observed recently that:

> Few epochs in history have included such startling changes within a single generation as that between the eighties and the present. It is a hazardous task to attempt to portray the large outlines of a nation's changes and tendencies for the era of the present generation, especially an era of revolutionary changes in the material, political and social composition of a people. There have been generations of such stationary character that the historian's task in dealing with them is simple if not inspiring. But the very fact, that the generation which has passed . . . is one of such complexity and of such extraordinary change that it daunts the historian and almost forbids the attempt, is at the same time a challenge. For unless the American people turn at times from the rushing current of events to take observations, to look to the chart of their course, to measure their progress or decline, and survey its stages, they are not likely to comprehend the direction in which they are going, the meaning of the voyage, or the measures to pursue in the coming years. No one is wise enough, no one is far enough removed from the action, adequately to make this survey. The prepossessions and the prejudices, the survival of old conceptions, the complexity of the problems, are too great. It requires the base line which only coming generations can draw to measure the full meaning of these recent years and to reckon the things that should have been done and those that should have been undone.
>
> Nevertheless a generation that does not attempt to consider its recent past is like the merchant who ignores his ledger, the mariner who takes no observations. However imperfect the results, it is necessary that the attitude of mind should be achieved. . . .

The dominant fact in American history during this period is the triple economic revolution which began its protean changes in England during the latter part of the eighteenth century and extended to the continent of Europe and the United States in the nineteenth century. Agriculture was transformed from a simple, pioneer and largely self-sufficing occupation into a modern business organized on a scientific, capitalistic and commercial basis; industry definitely underwent the change from hand labor in the home to machine production in the factory; and the local market was transformed into the world market. This threefold revolution in agriculture, industry and commerce is the key to the study of the recent history of the United States. While the antecedents of the economic revolution were already in evidence before 1860, it was the war between the states that hastened the tendencies and produced the changes that were destined to transform the economic and social structure of the nation and give rise to complex problems of reorganization and readjustment which to-day challenge the social sciences. With these observations in mind we may proceed to a consideration of the forces underlying the agricultural revolution in the United States.

I. The Passing of the Public Lands into Private Ownership

The entire continental land area of the United States, excluding Alaska, amounts to 1,903,290,880 acres. The public domain comprised three fourths of this area, or 1,442,200,320 acres; while the remaining one fourth, consisting of the original thirteen states and the states of Kentucky, Tennessee and Texas, embraces an area of 461,090,560 acres which did not come under the control of the federal government and so was never a part of the public domain. Of this vast domain, the federal government had by 1860 disposed of 394,088,712 acres, thus leaving for future disposition an area amounting to 1,048,111,608 acres, the greater portion of which was located in the public land states west of the Mississippi River. The rapid disposal of the public lands dates from 1862 with the passage of the homestead act, the land grant college act and the act providing for a grant of land for the first transcontinental railroad. Under the provisions of the homestead law, the government during the period ending with June 30, 1929, disposed of 232,259,180 acres of land—an area equal to six times the area of Iowa. The preemption act of 1841, the timber culture act of 1873, the desert land act of 1877 and the timber and stone act of 1878, together with the right granted under the homestead law, enabled any person to acquire the title to 1,120 acres of land. Large areas of timber and mineral lands were acquired under other laws. The utilization of inferior lands was made possible by the Carey Act of 1894, the reclamation act of 1902 and subsequent legislation. The huge grants of land to states and corporations for the construction of railroads, wagon roads and canals, and for the advancement of education also facilitated the disposal of the public domain. The

establishment of forest and Indian reserves further reduced the amount of public land available for private entry.

This legislation made possible the rapid alienation of the public lands. The report of the commissioner of the General Land Office shows that in spite of the liberal policy of the federal government the remaining area of public land, unappropriated and unreserved, amounted on June 30, 1929, to 190,031,722 acres, located for the most part in the mountain and Pacific Coast states. The greater portion of this area, however, will never be available for agricultural purposes.

The transfer of this vast heritage from public to private ownership was accompanied by a corresponding increase in the farming area of the country. The number of farms was increased from 2,044,077 in 1860 to 4,008,907 in 1880. In 1900 there were 5,737,372 farms in the United States. This number was further increased to 6,448,343 in 1920. The number of acres in farms was increased from 407,212,538 acres in 1860 to 536,081,835 acres in 1880. This was further increased to 838,591,774 acres in 1900 and 955,883,715 acres in 1920. The average number of acres in farms was reduced from 199.2 acres in 1860 to 133.8 acres in 1880, due largely to the breaking up of the plantation system and the operation of the homestead law. This was increased to 146.2 acres in 1900 and 148.2 acres in 1920 but reduced to 145 acres in 1925; while the average number of acres of improved land in farms was reduced from 79.8 in 1860 to 71 in 1880 and then increased to 72.2 in 1900 and 78 in 1920. That is to say, the average size of farms and the average amount of improved land in farms remained fairly constant throughout the period.

The passing of the public lands has been accompanied by significant changes which characterize American agriculture in the twentieth century. Among these changes may be mentioned: (1) the rapid rise of land values and the consequent transition from extensive to intensive farming; (2) the growth of tenancy; (3) the decline of the agricultural export trade; (4) the utilization of the inferior lands, and (5) the reorganization of rural life. The passing of the public lands has brought agriculture to the crossroads with modern industry. This is perhaps the most distinctive phase of the agricultural revolution in the United States.

II. The Rapid Growth of Population and Immigration

The population of the United States, excluding the non-contiguous possessions, numbered 31,443,321 in 1860 and 62,947,714 in 1890. By 1920, it passed the one hundred million mark, reaching the number of 105,710,620. That is to say, population was doubled in thirty years and increased by three and a half times in sixty years. Immigration supplied 28,749,245. Of this number 10,373,628 arrived in the period 1860 to 1890, and 18,373,617 in the period 1890 to 1920.

The great abundance of good land and the liberal policy of the federal government in providing free homesteads for the settler attracted great numbers of immigrants from the Atlantic seaboard states into the farming states of the West. Hither came also large groups of European immigrants experienced in Old World methods of farming which they adapted to the requirements of a new frontier environment. They were as a rule industrious and thrifty, becoming a substantial part of the farming population and loyal American citizens. An agricultural empire was founded in the Mississippi Valley. Meanwhile, the Pacific Coast states were settled and added to this great imperial domain.

The population has until recently continued to be predominately rural. According to the United States census of 1880, the rural population (including towns and villages with less than 2,500 inhabitants) numbered 35,383,345, or 70.5 per cent. of the entire population. This was a number greater than the total population of the United States in 1860. In 1910 the rural population numbered 49,348,883, which was 53.7 per cent. of the entire population. The United States census of 1920 is the first to show that the majority of the American people now live in towns and cities: 48.1 per cent. being classified as rural, while 51.9 are classified as urban—the latter excluding towns and villages of less than 2,500 inhabitants, which are classified as rural. In 1910, 33.2 per cent. of all persons engaged in gainful occupations were engaged in farming—a greater proportion than was engaged in any other occupation. In 1920 the proportion of persons over ten years of age thus employed declined to 26.3 per cent., while the proportion of persons engaged in manufacturing and mechanical industries was increased to 30.8 per cent. This is a fact of fundamental significance in marking the emergence of the United States into an agrarian-industrial state.

These figures show that there has been a rapid increase in the rural population since 1790 and in the urban population since about 1880; but that while the rural population has been increasing, the urban population has been growing at a more rapid rate. That is to say, the rural population has entered upon a period of rapid relative decline, which is another way of saying that the population of the United States is becoming urbanized. Many students and writers have tended to lament the movement of population from the country to the city; to view with

misgivings the desertion of the farms and the concentration of population in crowded tenements; to urge the importance of checking this "trek to the cities," and even to propose a "back-to-the-land" movement. These views are opposed by those who urge that science, invention and power-driven machinery have made possible the migration of population from the country to the city; that this movement is inevitable; that it is destined to continue at an accelerated rate; and that it is really a natural process which is best for the nation as a whole.

Among those who hold this view may be mentioned the editor of *The Birmingham News*, who in a recent editorial made these significant observations:

> The forthcoming census is expected to show a greatly reduced population in the provinces and vastly larger urban increases in the last decade; for while those who quit the rural regions are coming to the congested centers, the great majority of immigrants also are drawn to centers where population is greatest. And despite the fact that the depleted rural population continues to supply sufficient food for the nation—largely because of intensive production aided by labor-saving machinery—sociologists still deplore the migration from country to town. Precisely why social students grieve over this movement is never stated very clearly. What is clear is that the reason for it is largely economic. What is plain as a pikestaff is that the foods, the wool, the cotton, the livestock of the future will be produced scientifically by trained farmers. What the tender-minded sociologist sees is the gradual tendency of American living to become complex. He deplores that families are moving in from the spacious acres, the green and fertile fields, away from the open air, to become industrial slaves—burdens to the labor market already glutted. But that is not altogether a fair picture. The question is whether an unskilled farmer, unable to wrest a living from sterile soil—since he lacks capital to fertilize it and brains to develop it—is worse off in the industrial centers where he must endeavor to wrest a living from the streams of trade.
>
> Doubtless this will be a puzzle for students to worry over for many years ahead. So long, however, as the trained farmers of the nation can produce sufficient bread, meat and textiles to provide the non-producing workers in the so-called "artificial industries," it must continue to be the paramount factor in that trek from the open spaces into towns where people rarely ever think of the processions of stars and suns. In times ahead when cities will become so greatly cluttered that the scientific farmers in the fields can not supply the demand for food, descendants of farmers who left the fields will go back.

Another view is expressed by Chester C. Maxey in his recently published book on "Urban Democracy." The writer observes that:

> The country is itself being urbanized. Automobiles, improved highways, telephones and radios are bringing the city to the country and the country to the city. A new chapter in country life is being written. The old distinctions between *rus* and *urbs* are gradually fading out. Agriculture is becoming a specialized industry, and the economic aspects of rural life are beginning to resemble those of the city. The truth is that city and country are alike caught in the same web of cosmic forces, and are doomed to share the same destiny. The outcome no man can foresee, but we know it will be shaped and determined by the ability of the human species to adapt itself to life in the great society which is being created by the urbanization of the modern world.

III. The Invention and Popularization of Improved Farm Implements and Machinery

"The year 1850 practically marks the close of the period in which the only farm implements and machinery other than the wagon, cart and cotton gin were those which for want of a better designation may be called implements of hand production. The old cast-iron plows were in use. Grass was mowed with a scythe, and grain was cut with the sickle or cradle and threshed with the flail." Although most of the epoch-making implements and machines which have revolutionized farming were invented and introduced into practical use before 1860, it was the Civil War decade that popularized these labor-saving devices. The withdrawal of hundreds of thousands of men from the farm to enlist in the army stimulated the use of such devices. The plow, the corn-planter, the two-horse cultivator, the mower, the reaper and the threshing machine rapidly overcame the conservatism of the farmer who, confronted with the alternative of losing his crops in the field for want of an adequate labor supply, now became convinced of the utility of these inventions when he saw it demonstrated, for example, that a reaper drawn by a team of horses and operated by one man could cut from ten to twelve acres of an ordinary stand of wheat in a day, whereas a man with a grain cradle could by laborious effort cut but an acre and a half to two acres of wheat in the same length of time.

Many notable mechanical improvements have been introduced and widely adopted since that time. The list is legion. The more recent introduction of power-driven machinery utilizing gas and electricity is a significant feature of this development. The question whether the horse or the tractor affords the most economical power for farm use is the subject of a lively controversy which must be decided by the farmers themselves with reference to their individual circumstances. The use of improved farm implements and machines has not only added greatly to the productivity of each unit of land and of labor but it has also made possible the intensive cultivation of a larger area of land. The topography of considerable areas of the

arable land of this country is comparatively level, which favors the use of farm machinery on a larger farm unit basis. The tendency of farmers to specialize in a few staple crops adds still further to the advantages of machinery, while the relatively large size of American farms makes the use of machinery economical. It is therefore apparent that while the size of farms varies, depending on the type of farming carried on, a farm "ought to be large enough to occupy the reasonable working time of the farmer and his family when they use the best and most efficient tools and machinery known to the farming world, with ample horse power, or some other form of power to drive that machinery." The tendency in the United States has been to reduce as much of the farm work as possible to mechanical process. This is one of the most significant aspects of the revolution in American agriculture.

IV. The Extension and Development of Transportation Facilities

The history of the United States from the beginning of colonization is in a very real sense the history of the development of transportation and communication. Prior to 1850, the principal avenues for the disposal of farm products were the two great waterways of the country: (1) the Mississippi River with its navigable tributaries, and (2) the Great Lakes with their eastern connections, the Erie Canal and the Hudson River and the Welland Canal and the St. Lawrence River. The early railroads in the Middle West were regarded as tributaries of the waterways; but the rapid extension and improvement of railway facilities after 1850 was destined to effect profound changes in both agriculture and industry and to revolutionize the whole course of internal trade. In 1860 there were 30,626 miles of railroad in operation, distributed equally among the three great sections of the country: the East, the South and the West. The rate of construction was checked somewhat during the war between the states, but immediately after the war the entire country was seized with a mania for railroads. In 1870 there were 52,922 miles in operation. This was further expanded to 93,922 miles in 1880 and 166,654 miles in 1890, finally reaching 198,904 miles at the close of the century. Railway expansion continued, amounting in 1910 to 249,992 miles and in 1916 to 254,251 miles. Since that date there has been a continuous annual decrease of railway mileage, which in 1927 amounted to 249,131 miles. The country was spanned with a network of railroads. Chicago became the greatest railway center in the world, with St. Louis as a keen competitor for first place. Five transcontinental railroads were constructed, thus bringing the Pacific Coast states into direct economic relationships with the Mississippi Valley and the Atlantic seaboard states.

No less important than the rapid growth of mileage were the great improvements which accompanied the development of rail transportation. Reference should be made especially to the reduction of grades and curves, improved drainage and ballasting, better bridges, the introduction of steel rails, the increase in the capacity of freight cars and in the drawing power of locomotives, the adoption of uniform gauges, the establishment of belts of standard time, the development of terminal facilities, including side tracks, warehouses and terminal elevators, and scientific rate-making.

These improvements, supplemented by the advantages afforded by rapid transit and reduced risks, tended to increase the value of railroads as commercial highways which by the middle of the seventies had become effective competitors of the waterways in the transportation of farm products. The introduction of the iron steamship on the ocean after 1860 and the formation of combinations between railroad and steamship lines, which made possible the shipment of products on through bills of lading from interior points to the markets of Europe, further increased the importance of the railroads as carriers of farm products. These developments were further accompanied by improvements in the facilities for communication which served to bring all sections of the country and the nations of western Europe into more interdependent relationships. Of these, the telegraph was the most important agency for the rapid dissemination of information without which the organization and management of the modern commercial system would have been impossible. The improvement of the postal system, the growth of newspapers and trade journals, the invention and extension of the telephone system, the organization of produce exchanges and the modern system of banking and rural credit facilities also performed incalculable services in transforming agriculture from the self-sufficing into the commercial stage.

The extension and development of transportation facilities, rapid though it has been, has not kept pace with the surplus production of farm and factory. The inadequacy of the present system for the handling of this surplus, combined with high freight rates, has led to the urgent demand since Roosevelt's administration for the improvement of our great inland waterway system. This includes two great projects of importance to the Middle West: the restoration of the upper Mississippi River to its former importance as a carrier of bulky products such as grain and lumber and also coal and machinery; and the development of the Great Lakes-St. Lawrence waterway. These

projects are opposed by the commercial interests of the East, which foresee in the construction of this route and the consequent development of great seaports in the American Mediterranean the destruction of a monopoly of the western traffic in grain and livestock products which it has held since the completion of the Erie Canal.

The twentieth century marks the beginning of a new epoch in the history of transportation. The new heralds of progress are the automobile and the airplane. In 1900 there were 8,000 automobiles in the United States. Had any one then predicted a million automobiles within a generation he would have been ridiculed for his child-like fancy; but in how short a time would his prophecy have been redeemed? There are now 25,000,000 automobiles in the country: one to every four of the population! What a great influence this fact has had on the good roads movement and on rural civilization! There are now about 8,000 commercial airplanes in use in the United States, which is equal to the number of automobiles in 1900. Aviation is indeed on the threshold of a new era of remarkable development. The Curtiss Airport Corporation has definitely inaugurated a program of constructing twenty-five or thirty airports in this country and the island possessions, each airport costing from $2,500,000 to $3,000,000. Who can doubt the tremendous possibilities of commercial aviation and its importance as a factor in reconstructing rural life?

V. The Migration of Industries from the Farm to the Factory

The distinguishing feature of farm life in the pioneer period was its economic self-sufficiency. There was no market for farm products; consequently no goods could be purchased from the outside. Each farm was "an economic microcosm," producing for itself practically everything that it consumed: food, clothing, furniture, linens, soap, candles and a great variety of minor articles essential to the farmer and his family. The transfer of these industries from the farm to the factory is the most significant aspect of the transition from self-sufficient to commercial agriculture. It is an interlocking feature of both the agricultural and industrial revolutions. This is emphasized by the fact that the farms furnish approximately three fourths of the raw materials of industry, while fully one half of the products sold by the farmer are purchased by our manufacturing plants. The transformation of farm products by industrial processes into goods ready for the consumer is therefore the basic fact in the transition from pioneer self-sufficiency to commercial agriculture and industry.

The migration of industries from the farm to the factory since 1860 is characterized by the evolution of technical processes of manufacturing, increased market demands due to the growth of population, the addition of many new products and the utilization of by-products, new methods of marketing, improved methods of factory organization and management, concentration of manufacturing into large establishments and the localization of industries at advantageous points. These forces made possible increasing specialization which characterizes the transition from self-sufficient to commercial agriculture.

The industries that have been transferred from the farm to the factory may be classified into three groups: (1) food products; (2) textiles and clothing, including boots and shoes; and (3) tobacco and a number of minor products. The food industries include slaughtering and meat packing, flour milling, the manufacturing of dairy products, the canning of fruits and vegetables, the preparation of poultry and its products and the production of preserves and pickles. Many new industries have been added, such as the manufacture of beet sugar and the production of bread, pastries and confections. The list of package products includes a considerable number of animal and vegetable products. In 1860 flour and grist mills ranked first among the manufacturing industries in valuation of products, which amounted to $248,580,000. In 1919 slaughtering and meat packing ranked first with a total output valued at $4,246,290,000, while iron and steel ranked second in products, valued at $2,828,902,000, and automobiles ranked third with a valuation of $2,387,903,000. The products of all food industries were valued at $12,438,891,000, which was 20 per cent. of the total value of manufactured products in the United States.

The transfer of the textile and clothing and the boot and shoe industries from the farm to the factory has been studied chiefly from the standpoint of the development of manufacturing in the United States, but it deserves the attention of students of the history of American agriculture. It has been estimated that the household production of textiles in 1820 constituted more than two thirds of the entire product. The age of homespun gave way to the factory system by the operation of the same forces that took the food industries out of the home and placed them in the factory. In 1919 the total value of manufactures of textiles and their products amounted to $9,216,103,000.

The significance of the transfer of these industries from the farm to the factory can hardly be exaggerated. It is "the best evidence of the extent and rapidity of the transition from self-sufficient to commercial agriculture."

VI. The Expansion of Domestic and Foreign Markets

These forces made possible a territorial division of labor which enabled each section to devote itself more exclusively to the production of those commodities for which it was best adapted: the East to manufacturing and commerce; the South to the raising of cotton, cane and tobacco, and the West to the production of grain and live stock. That is to say, there were created three great economically interdependent sections bound together by reciprocal trading interests. The East became the home market for the surplus products of the West and the South, taking grain and flour and meat for its rapidly growing urban population and raw materials for its factories and offering in return the products of its factories.

The volume of production, however, exceeded the demands of the home market, thus giving rise to an annual product far in excess of the needs of the country, but for which there fortunately existed a growing demand abroad. The development and expansion of the facilities for the transportation and handling of bulky products and the reduction of freight rates transformed the local into the world market, the effect of which was twofold: first, it stimulated the production of food in the great agricultural regions which now had access to the markets of the world; and, second, it subjected the agricultural systems of the western European countries to a severe strain of competition which compelled large numbers of the rural population to abandon farming. As a result, they either migrated to the industrial centers to enlist in the army of wage-earners or emigrated to the New World, the greater proportion of them settling in the United States, which furnished unequaled opportunities for the making of an independent living. The countries of Europe thus became the natural market for the breadstuffs and live-stock products and the cotton and tobacco which entered into the export trade of the United States. The most important market for these commodities was Great Britain, which after the repeal of the Corn Laws in 1846 was transformed from an agricultural into an industrial nation largely dependent on foreign nations for an adequate supply of foodstuffs and raw materials. The nations of continental Europe were second in order of dependence, while the non-European countries of South America, the West Indies, Canada, China, Australia and South Africa came next. These countries all furnished markets that absorbed the surplus agricultural products which the United States had available for export. Meanwhile Russia, India, Australia, Canada and Argentina became strong competitors of the United States for this trade.

The principal items entering into agricultural export trade of the United States during the period under review were grain and flour, live-stock products, cotton and tobacco. The rapid expansion in the volume of these exports during the latter part of the nineteenth century was followed by a marked decline during a period of approximately fifteen years preceding the outbreak of the World War. Grain and flour and live-stock products declined at a precipitous rate, while cotton and tobacco continued at a fairly steady rate. The forces contributing to the sharp reduction in grain and meat exports were: (1) the tariff policies of France and Germany; (2) the competition of Argentina, Canada and Russia; and (3) the growth of the home market. These forces are of a permanent character, thus pointing to the day when the United States will cease to be a food-exporting nation.

The present agricultural situation in the United States is due in no small measure to the fact that Europe during the last decade has been unable to absorb its normal share of our exportable surplus. This condition will probably not be remedied until European nations have recovered their prewar purchasing power and world markets have again become stabilized. Domestic legislation may provide temporary relief; but it will not solve the problem. The farmer is dependent on foreign markets for the disposal of 60 per cent. of his cotton, 20 per cent. of his wheat and 15 per cent. of his pork and lard. He is dependent on Europe for the absorption of 80 per cent. of his whole exportable surplus. But the reduced purchasing power of Europe is a factor of more or less permanence. Moreover, Europe has been going back to the farm, with the result that it is to-day really less dependent on American food products than in the prewar period. But let us suppose that the European countries recover their former purchasing power. The United States has come to the end of the free land epoch and entered the period of high-priced land and high cost of production while Canada, Australia, New Zealand, South Africa, Argentina and Russia, with low-priced land and low cost of production, have become competitors of the United States in the markets of the world for the disposal of their surplus food products. The advantages lie with the new countries.

The present insecurity of the farmer in the foreign market of the world is therefore more or less permanent. There is but one alternative which offers any hope of escape from this condition. This alternative is the reorganization of American agriculture to meet the demand of a rapidly expanding home market. This means that the time has come when less attention should be given to the production of the great world

agricultural staples such as wheat, pork and cotton and more attention to the production of perishable and semi-perishable commodities—dairy products, vegetables, fruits and the like. But even so, it will be some time before we cease to be a food- and cotton-exporting nation, for the reorganization of agriculture along the lines suggested can not be effected in less than a generation for reasons which are inherent in the nature of the farming business.

VII. THE ESTABLISHMENT OF AGENCIES FOR THE PROMOTION OF SCIENTIFIC KNOWLEDGE RELATING TO AGRICULTURE

Interest in scientific farming dates back to the beginning of the national period of our history, but this interest was shared by but a comparatively small number of progressive farmers. The great mass of the rural population followed the rule of tradition, custom and superstition which prevailed throughout the pioneer period. The reluctance to apply scientific principles to the practice of farming is explained by the fact that it was easier and more economical to acquire and cultivate new land than to institute intensive methods on the older land. Moreover, the farmers generally possessed a very meager knowledge respecting the proper treatment of soils and plant life, even the most intelligent farmers, including the scientists themselves, knowing very little about such matters. Then, too, the great majority of farmers were averse to new ideas and methods which they regarded as "book farming" and therefore as impracticable. This attitude is due largely to the fact that the farmers of the pioneer period, accustomed to a life of isolation and separation from their fellowmen, were naturally independent and extremely individualistic, relying on their own initiative and taking pride in following their own peculiar methods of farming, when it would have been easier and less expensive for them to seek and follow the advice and experience of others.

The rapid disposal of the public domain after 1862 soon brought the nation to the end of the free land era when rising land values made it necessary for the farmer to change from extensive to intensive methods; and the transformation of agriculture from the pioneer into the commercial stage brought the farmer into closer relations with the business world. The new conditions thus created broadened the farmer's outlook and awakened him to a realization of his educational needs and opportunities. This period also witnessed the rise of a new generation of farmers who were ready to abandon primitive methods of farming and adopt scientific methods as soon as their utility was demonstrated. Agriculture, thus liberated from the fetters of custom and tradition, was prepared to enter upon a new era of development. This led to the creation of agencies for the promotion of scientific knowledge relating to agriculture. The limits of this paper will permit only a brief consideration of these agencies in the education of the farmer along scientific and practical lines.

The Federal Government first took an active interest in the promotion of agriculture in 1839, when, on the recommendation of the commissioner of patents, an appropriation of $1,000 was made for the "collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement of cuttings and seeds for gratuitous distribution among the farmers." The work was gradually developed by the Patent Office, through its agricultural division, until 1862, when the Department of Agriculture was established. The functions of this department as defined by law were "to acquire and diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word, and to acquire, propagate, and distribute among the people new and valuable seeds and plants."

This department grew slowly at first, owing to inadequate moral and financial support; but as the need for a scientific knowledge relating to agriculture developed, the functions of this department were gradually expanded. By 1889 it had finally achieved sufficient dignity to be raised to the rank of a cabinet office. Thereafter the work of the department was rapidly developed until it became the leading government agency of its kind in the world for the promotion of scientific research relating to all lines of agricultural development, including plant and animal life, crop production, insect pests, trade and commerce, irrigation, statistics, quarantine and road-making—almost everything, indeed, affecting the interests of those engaged in the raising and marketing of agricultural products. In 1927 the total expenditures of the department amounted to $153,049,018.

The U. S. Department of Agriculture is supplemented by the state departments, most of which have been established since 1860. The functions of these may be defined in general terms as follows: the collection, publication and distribution of crop statistics; the holding of state and district fairs; the conducting of farmers' institutes; the enforcement of laws relating to live stock and human foods; the control of insect pests and fungus diseases in orchards, nurseries and vineyards; the enforcement of quarantine laws against animal diseases; the operation of experimental farms; the distribution of seeds and plants, and the preparation and publication of annual reports, journals and bulletins.

The same year in which the U. S. Department of Agriculture was established marks also the passage

of the land-grant college act, providing for the establishment of colleges of agriculture and mechanic arts. According to the provisions of this law, each state received 30,000 acres of public land for each representative and senator to whom the state was entitled in Congress under the apportionment of 1860. The interest on the money derived from the sale of this land was to be appropriated for "the endowment, support, and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

The land-grant act of 1862 was the most important specific enactment ever made for the promotion of scientific knowledge relating to agriculture in the United States. It gave a great stimulus to the movement, already inaugurated before 1860, for the establishment of state-supported institutions of learning devoted to "the liberal and practical education of the industrial classes." Many states accepted the conditions of the grant soon after the passage of the act. There are now sixty-nine institutions in the United States receiving the benefits of this grant.

The land-grant colleges underwent a period of slow development during the first twenty-five years of their existence. It was a period of organization and of discussion as to what the character of these institutions should be in order to fulfil the purpose of the act and to meet the needs of "the industrial classes" in the respective states. Courses in the study of the sciences were yet to be developed, teachers in these subjects were to be trained and the system of elective studies was to be organized, while graduate courses of instruction and research remained to be developed later. It was therefore impossible to develop technical courses in agriculture until the sciences were placed on a sound basis with adequate equipment and well-trained teachers in charge of these courses. The most important functions of the land-grant colleges during this period were, therefore, first, the establishment and perfection of instruction in the natural sciences; and, second, the development of technical courses suited to the needs of farmers and mechanics. At the same time, they gave instruction in a variety of general subjects, thus developing a broader view of what constitutes a liberal education. Finally, they rendered a valuable service in preparing teachers and scientists who later rose to eminence in the work of technical instruction as well as in scientific and practical investigations.

The natural outgrowth of this development was the experiment station. The first regularly organized experiment station in the United States was established by the state of Connecticut in 1875. Other states followed until by 1887 there were seventeen stations in operation in fourteen states. In that year, Congress passed the Hatch Act providing for the establishment and maintenance of experiment stations as departments of the land-grant colleges in all the states and territories. The experiment station thus became an integral part of the agricultural college, while its work has formed the basis of all instruction relating to the science of agriculture. In addition to this, it has performed a valuable service in the publication and dissemination of bulletins on a variety of subjects of great interest and importance to the farmer.

By 1890, the land-grant colleges were beginning to achieve a place of influence and prestige among the better colleges and universities of the country. Since that year these institutions have undergone a rapid growth and development along three clearly defined lines: first, teaching; second, research and experimental work, and, third, extension work. The development of this threefold function has made the land-grant college, in cooperation with the U. S. Department of Agriculture, an important factor in the transformation of farming from a pioneer occupation into a modern business organized on a scientific basis.

The rise and growth of farmers' organizations should also be mentioned as one of the important agencies for the diffusion of knowledge relating to the practice of farming. The revolution in agriculture gave rise to complex problems of production, distribution and exchange which were of fundamental interest and importance to the farmers. As agriculture became more interwoven with the fabric of our national economy, these problems became more and more acute. It was therefore natural that the farmers should follow the example of other economic groups and organize for the promotion of their interests. This period, consequently, witnessed the formation of many organizations which may be divided into two general groups: first, those serving some special end or industry, as, for example, the cooperative creamery associations and the farmers' elevator companies; and second, those which sought to unite the farmers as a class, among which organizations may be mentioned the Granger, Greenback, Farmers' Alliance, Populist and Farm Bureau movements. These various organizations—local, state and national—performed a great service in the education of the American farmer. They aided in breaking down the barriers which had heretofore separated the farmers from their

fellowmen, developed in the farming population a feeling of class consciousness, taught valuable lessons in cooperation and became an important agency for the dissemination of the new ideas and methods in farming which were being advanced by the agricultural colleges and experiment stations.

Of inestimable importance, finally, as an agency for the promotion of scientific knowledge relating to agriculture was the agricultural press. It would be difficult, indeed, to estimate the influence of the agricultural press on the development of scientific farming in the United States. From the beginning it has dealt with an infinite variety of subjects; it has been one of the most efficient agencies for the popularization of the results of scientific experiments conducted by the agricultural colleges and experiment stations, and it has accorded much space in its advertising columns to ways and methods of improving the practice of farming.

The significant aspects of the agricultural revolution in the United States may now be stated: (1) the passing of the public lands into private ownership; (2) the rapid growth of population and immigration; (3) the invention and popularization of improved farm implements and machinery; (4) the extension and development of transportation and communication; (5) the migration of industries from the farm to the factory; (6) the expansion of domestic and foreign markets; and (7) the establishment of agencies for the promotion of scientific knowledge relating to agriculture, among which may be mentioned, especially, the federal and state departments of agriculture, the agricultural colleges and experiment stations, including rural extension work, the farmers' organizations, with their economic, social, educational and political functions, and the farm press. These forces transformed farming from a pioneer and largely self-sufficing occupation into a modern business organized on a scientific, capitalistic and commercial basis. Farming became inextricably bound up with the business world. It had become indeed the warp, with industry as the woof, of our national economy. These new developments and relationships gave rise to many problems which to-day confront the nation and which require for their solution a thorough scientific knowledge of farming and a sound, far-sighted and well-balanced statesmanship.

The agricultural situation in the United States during the last decade has produced a large volume of discussion of the farm problem. "In considering this discussion," observes Dr. C. L. Holmes, "one is struck by the fact that almost all of it has been from the point of view of the immediate situation, and (that) but little has been said of the long-time aspects of the problem." Dr. Holmes then proceeds to state the long-time aspect of the problem in the following terms:

> An analysis of the present agricultural situation, and causes which have operated and are still operating to bring it about, seems to justify the conclusions: first, that the present depressed condition of our agriculture is due primarily to certain more or less permanent results of the World War, first, in the direction of expanding our agricultural output and, second, of impairing our foreign market for agricultural products and of redirecting the currents and changing the content of our international trade; second, that the recovery of our agricultural industry depends upon the adjustment of our agricultural production, both qualitatively and quantitatively, to the domestic market; and third, that the result of these necessary adjustments will be the beginning of a new era in American farming, representing as profound a change as that which came with the shift from self-sufficing to commercial agriculture.

Dr. Holmes adds, however, that this "does not point to a policy of inactivity and indifference. The emergency truly is great enough to demand the best thought and effort of our agricultural leadership. Probably no previous period has presented so great a need as the present for the best effort of educators, legislators and the leaders of the farmers' movement toward making general an intelligent view of the real nature of the situation, toward making as easy as possible the adjustment to the new alignment of forces, and toward developing unity of purpose and concerted action on the part of the agricultural class. There was never so great a need, and probably never so great an opportunity, for the development of a comprehensive and far-reaching agricultural policy."

OBITUARY

MEMORIALS

THE unveiling of a bronze memorial tablet of Dr. William Royal Stokes in the municipal building, Baltimore, took place on November 26. Dr. C. Hampson Jones, commissioner of health, presented the tablet and addresses were made by Dr. William H. Welch, professor of the history of medicine in the Johns Hopkins School of Medicine, and Dr. Hugh S. Cumming, surgeon-general, U. S. Public Health Service. The tablet bears the relief portrait of Dr. Stokes and underneath the inscription: "To the memory of an able physician and bacteriologist. A lover of art, music and poetry, who died a martyr to the cause of science, contracting psittacosis (parrot fever) in line of duty."

Under this is the inscription: "Erected by his fellow-employees of the Baltimore City Health Department, 1930."

IN the presence of relatives and friends, among whom were members of the faculty and many former students, a portrait of the late Dr. Henry P. Talbot, dean of students from 1921 to 1927, was recently shown for the first time in the office of Dean H. E. Lobdell, at the Massachusetts Institute of Technology. Dr. Talbot, whose death occurred in 1927, was a professor in the department of chemistry at Technology from 1892 to 1927, and he was head of the department from 1901 until 1922. The portrait was painted by E. Pollak-Ottendorff, of Boston. It is a gift to the institute from a group of former students, and its title plate bears this legend: "As alumnus, teacher, and administrator for forty years, he gave conscientiously and unselfishly of his brain and heart to the upbuilding of the institute."

AT the annual meeting of the Michigan Section of the American Institute of Chemical Engineers, held at Ann Arbor on November 11, the following memorial to Herbert H. Dow, founder of the Dow Chemical Co., was adopted: "The death of a leader brings to our minds a feeling of pride over his achievements as well as grief at our loss. It is with these mingled feelings that we pay tribute to the memory of Herbert H. Dow, recognized the world over as a brilliant leader in the field of chemical manufacture, but known to us also as a sincere and helpful associate and friend, willing to give freely from his store of knowledge and experience. We extend our deep sympathy to the family, and to those who labored so intimately with him in the great plant which will stand as a monument, not of dead stone, but of living service continuing as it did in his life time."

THE College of Physicians of Philadelphia held a meeting on October 23 to commemorate the anniversary of the birth of Galen, called the founder of experimental physiology. Ninety-three of the ninety-eight Galen publications, the property of the college library, were on exhibition. The meeting was addressed by Drs. William H. Welch, Charles W. Burr, Burton Chance and Giuseppe Franchini, of Bologna, Italy.

PROFESSOR ALBERT EINSTEIN made an address before the Prussian Academy of Sciences on November 26, in commemoration of the three hundredth anniversary of the death of Johann Kepler.

RECENT DEATHS

JAMES H. EMERTON, an authority on spiders, illustrator of scientific books and constructor of zoological and anatomical models, died on December 5 in his eighty-fourth year. From 1906 to 1919 Mr. Emerton was secretary of the New England Federation of Natural History Societies. He was a brother of Professor Ephraim Emerton, of Harvard University.

WILLIAM PENN RICH, botanist, for twenty-one years secretary and librarian of the Massachusetts Horticultural Society, died on November 30, at the age of eighty-one years.

PROFESSOR ALFRED ELY DAY, professor emeritus of natural sciences at the American University of Beirut, Syria, died on December 3.

DR. ERNEST ELLSWORTH SMITH, a specialist in experimental medicine and clinical pathology and president of the Medical Association of Greater New York, died on December 5 at the age of sixty-two years.

THOMAS G. GERDINE, engineer in charge of the Pacific division of the U. S. Geological Survey, with headquarters in Sacramento, has died at the age of fifty-eight years.

HEINRICH GUSTAV ADOLF ENGLER, long professor of botany at the University of Berlin and director of the botanical garden and museum, died on October 10, at the age of eighty-six years.

THE death is announced of Dr. Rudolf Disselhorst, professor of comparative anatomy at the University of Halle.

SCIENTIFIC EVENTS

THE LIBRARY OF THE DEPARTMENT OF AGRICULTURE

INCREASED appropriations made possible the addition of 16,563 books, pamphlets and maps to the Library of the U. S. Department of Agriculture in the fiscal year 1929, according to the annual report to Secretary of Agriculture Hyde, of Miss Claribel R. Barnett, librarian. This was 2,209 more than the number added the previous year. On June 30 the library contained 218,038 volumes on agricultural and scientific subjects and was receiving 4,080 periodicals. It receives 128 daily newspapers. More than 268,000 books and periodicals were circulated in this period. In addition to the main library, branch libraries are maintained in the various bureaus of the Department of Agriculture, dealing with the subjects of special interest to these bureaus.

In cooperation with the land-grant college and ex-

periment-station libraries, the library issues a mimeographed publication, Agricultural Library Notes. Under a cooperative arrangement between the department and the editors of *Biological Abstracts*, the latter has opened a branch office in Washington and has been assigned office space in the main library. An increase of $5,000 in the library appropriation was also secured to make possible an increase in the library accessions in the field of biology. Dr. F. V. Rand, who is in charge of the Washington office of *Biological Abstracts*, reports that as a result of this cooperation, about 850 serial publications which have not hitherto been available are now being covered in the abstracting work. Other cooperative bibliographical projects are being carried on by the branch libraries, particularly with institutions and associations. The library of the Bureau of Agricultural Economics is cooperating with the Bureau of International Research and the American Country Life Association; the library of the Bureau of Entomology with the Association of American Economic Entomologists; the library of the Forest Service with the National Research Council; the library of the Bureau of Plant Industry with the Wild Flower Preservation Society, and the library of the Bureau of Public Roads with the American Association of State Highway Officials.

In cooperation with the division of bee culture investigations, a list of publications on apiculture contained in the library has been issued as No. 21 in the series of "Bibliographical Contributions" of the library. The bibliography on rural standards of living, prepared in the library of the Bureau of Agricultural Economics the past year, was published recently. The fourth Index to the Literature of American Economic Entomology, covering the years 1925–1929, prepared by the librarian of the Bureau of Entomology, is now in press.

BLIGHT RESISTANT CHESTNUTS FROM THE ORIENT

R. KENT BEATTIE, a plant explorer who has been searching the domains of the Formosa head-hunters and the forests of Korea and Japan for blight-resistant chestnuts to plant in American forests, has returned to Washington. Mr. Beattie is a forest pathologist of the U. S. Department of Agriculture.

During two and a half years Mr. Beattie collected about 250 bushels of chestnuts of native strains, and scions of about 90 cultivated varieties. He shipped these nuts and scions to Washington as fast as he collected them and the Department of Agriculture planted them in its forest nursery at Glendale, Maryland, to test their resistance to blight and their adaptation to the climate and soil of a new homeland. These plantings produced about 250,000 seedlings.

Last spring the department placed 73,000 seedlings grown from Mr. Beattie's 1928 collections with foresters and experiment stations in Connecticut, Massachusetts, New York, New Jersey, Pennsylvania, Delaware, Maryland, West Virginia, Virginia, North Carolina, Georgia, Alabama, Tennessee, Kentucky, Louisiana, Ohio and Michigan for testing.

Pathologists and foresters hope that blight-resistant chestnuts eventually will be established throughout the chestnut-growing states, where blight is rapidly depleting the stands of native chestnut. The American chestnut is still the source of more than 50 per cent. of our vegetable tannin. Tests by the department show that the Japanese chestnut is an equally good producer of tannin. Mr. Beattie reached Japan in the summer of 1927. He visited the areas of Japan where the chestnut grows and arranged with official foresters, representatives of the Imperial Household, agricultural cooperative marketing associations and chestnut growers to ship nuts to him at Tokyo or Yokohama. After gathering chestnuts from every accessible region of Japan, Korea and Formosa, Mr. Beattie made a return trip around more than half of the globe, gathering information about the chestnut and related trees.

THE DE LAMAR LECTURES

THE list of De Lamar Lectures in Hygiene this session at the School of Hygiene and Public Health of the Johns Hopkins University is as follows.

"The Rôle of the Anaerobic Bacteria in Human Pathology," Dr. M. Weinberg, professor at the Pasteur Institute, Paris, October 21.

"The Serotherapy of Medical and Surgical Infections Caused by Anaerobic Bacteria," Dr. M. Weinberg, professor at the Pasteur Institute, Paris, October 22.

"The Economic Aspects of Medical Care in this Country," Dr. Willard C. Rappleye, director of study, Commission on Medical Education, New Haven, Connecticut, November 4.

"Acid-fast Bacteria: Their Relation to Disease and the Need for Better Preventive Measures," Dr. William Charles White, chairman, Medical Research Committee of the National Tuberculosis Association, November 25.

"Recent Progress in Yellow-fever Research," Dr. W. A. Sawyer, associate director International Health Division, Rockefeller Foundation, December 9.

"The Epidemiology of Poliomyelitis," Dr. W. Lloyd Aycock, assistant professor of preventive medicine and hygiene, Harvard Medical School, January 6.

"Factors influencing Vitamin Distribution in Foods," R. Adams Dutcher, professor of bio-chemistry, Pennsylvania State College, January 27.

"Venereal Diseases," Dr. Thomas Parran, Jr., commissioner of health, State of New York, March 3.

"Hypersensitivity to Bacterial Proteins and its Rôle in Susceptibility and Immunity," Dr. W. B. Wherry, professor of bacteriology, University of Cincinnati, March 31.

"The Prevention and Cure of Narcotic Drug Addiction," Dr. George F. McCleary, deputy senior medical officer, Ministry of Health, England, April 14.

THE TEXAS ACADEMY OF SCIENCE

THE Texas Academy of Science held its annual meeting from November 28 to 29 at Baylor University, Waco, Texas, with a large attendance of members. The program, which consisted of twenty numbers, was given in three sections; the first was given over to the exact sciences; the second to the biological sciences, and the third to the educational sciences. Those giving the papers were widely distributed in their connections. The University, A. & M. College, Teachers Colleges and numerous denominational colleges were represented. The night of November 28 Dr. S. L. Brooks, president of Baylor University, entertained the academy with a banquet.

In the business meeting it was announced that the academy had received its charter from the state; that it had been affiliated with the American Association for the Advancement of Science; that its membership had grown within the last year from 79 to 300, and that it had issued Vol. XIV of the "Transactions and Proceedings." The academy adopted an amendment to its constitution providing for the formation of a Junior Academy of Science. Clyde T. Reed, the retiring president, was selected as chairman of the Junior Academy, with Miss Greta Oppe and Robert H. Cuyler as the other members.

The officers elected for the Academy of Science were J. K. Strecker, *president,* Baylor University; J. M. Kuehne, University of Texas, *vice-president Section I;* F. B. Plummer, University of Texas, *vice-president Section II;* W. J. McConnell, North Texas State Teachers College, *vice-president Section III.* Dr. S. W. Bilsing, A. & M. College of Texas, representative to the American Association Council, and H. B. Parks, San Antonio, *secretary-treasurer.*

The academy is entering its third year, as this is a reviving of the old academy, which existed from 1892 to 1915. So great is the interest shown in the work that the membership ordered the printing of a monthly bulletin and a volume of "Transactions and Proceedings" for next year.

PRESENTATION OF THE JOHN FRITZ MEDAL

THE John Fritz Medal, which had been awarded to Rear Admiral David Watson Taylor, retired, chief constructor of the United States Navy during the war, was presented at the annual dinner to new members of the American Society of Mechanical Engineers, given at the Hotel Astor on December 3 as part of the fifty-first annual meeting.

The award was made to Admiral Taylor "for outstanding achievement in marine architecture, for revolutionary results of persistent research in hull design, for improvement in many types of warships, and for distinguished service as Chief Constructor of the United States Navy during the World War." Mr. Bancroft Gherardi, chairman of the board which made the award, presented the medal after the recipient was introduced by Mr. Walter M. McFarland, past president of the Society of Naval Architects and Marine Engineers.

Another event at the dinner was the presentation of special badges to fourteen fifty-year members of the society. Mr. Thomas A. Edison was one of the fourteen. Mr. Fred A. Scheffler accepted the medal for him. The others were Ellwood Burdsall, Port Chester, N. Y.; John W. Cloud, London, England; J. S. Coon, Atlanta, Georgia; P. B. de Schweinitz, Bethlehem, Pennsylvania; Henry Marx, Cincinnati, Ohio; A. F. Nagle, H. F. J. Porter, Auguste A. Goubert and Francis H. Richards, all of New York City; Albert W. Smith, Ithaca; Ambrose Swasey, Cleveland; Edward N. Trump, Syracuse, and Walter Wood, Philadelphia. The badges were presented by Charles E. Gorton, vice-president of the society.

The speaker of the evening was Elliott Dunlap Smith, professor of industrial engineering at Yale University, and director of industrial investigations of the Institute of Human Relations, who spoke on the subject "Engineering Encounters Human Nature." There were also remarks by the president-elect of the society, Roy V. Wright, an address to the new members by Conrad N. Lauer, vice-president, and a roll-call of the new members by Calvin W. Rice, secretary. Lincoln Bush, past president of the American Society of Civil Engineers, presided. Ely C. Hutchinson, manager of the society, was the toastmaster.

The three other societies joining in awarding the John Fritz Medal are the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, and the American Institute of Electrical Engineers. The medal was established in 1902 in honor of John Fritz of Bethlehem, Pennsylvania, pioneer iron master and engineer, who was the first recipient. Others who have won the award include Lord Kelvin (1905), George Westinghouse (1906), Alexander Graham Bell (1907), Dr. Elihu Thomson (1916), General George W. Goethals (1919), Orville Wright (1920), Guglielmo Marconi (1923), Elmer A. Sperry (1927) and Herbert Hoover (1929).

SCIENTIFIC NOTES AND NEWS

PRESIDENT HOOVER has sent to the Senate the nomination of Dr. George Otis Smith, director of the Geological Survey since 1907, to be chairman of the new Federal Power Commission. Dr. Smith is named for the long term, expiring on June 22, 1935.

THE Swedish Medical Society has awarded its Pasteur Gold Medal to Dr. Emile Roux, director of the Institut Pasteur of Paris. The award is made every ten years.

PROFESSOR MAX PLANCK, now vice-chancellor, has become chancellor of the Prussian Order for Merit of Science and Art, to succeed the late Professor Adolf von Harnack. Dr. Ludwig Hoffmann and Dr. Ulrich von Wilamowitz-Moellendorff become first and second vice-chancellors, respectively.

SIR WILFRED GRENFELL delivered the inaugural address to the Royal Scottish Geographical Society in Edinburgh on November 21, and received the Livingstone Medal, which is the highest honor that the society can confer. The address was on "Labrador," the scene of Sir Wilfred Grenfell's life's work.

DR. ERNST ANTON WÜLFING, professor of mineralogy and petrography at the University of Heidelberg, celebrated his seventieth birthday on November 27.

DR. C. S. MYERS, director of the British National Institute of Industrial Psychology, has asked to be released from the duties of the directorship, and has been appointed principal, in order that he may devote the whole of his time to the institute's research and educational activities. Dr. G. H. Miles, who has been assistant director for several years, has been appointed director and will take charge of the practical activities.

DR. LAURENCE VAIL COLEMAN, director of the American Association of Museums, was appointed to the executive committee of the International Museums Office at a recent meeting in Geneva of the International Institute of Intellectual Cooperation. The seven other members of the committee represent Belgium, England, France, Germany, Italy, Spain and Switzerland.

DUE to the illness of Dr. A. O. Thomas, the treasurer of the Iowa Academy of Science, the executive committee of the academy has appointed Dr. W. F. Loehwing, of the Department of Botany of the State University of Iowa, to act as treasurer of the academy.

Nature reports that at the anniversary meeting of the British Mineralogical Society, held on November 4, the following officers were elected: *President*, Sir John S. Flett; *Vice-presidents*, Dr. G. F. Herbert Smith, Professor C. Gilbert Cullis; *Treasurer*, Mr. F. N. Ashcroft; *General Secretary*, Mr. W. Campbell Smith; *Foreign Secretary*, Dr. J. W. Evans; *Editor of the Journal*, Dr. L. J. Spencer.

LEAVE of absence has been granted to Professor Brash, dean of the faculty of medicine, of the University of Birmingham, and Professors Haswell, Wilson and Daly, to visit the United States as guests of the Rockefeller Foundation to inspect the buildings and equipment of medical schools in view of the building and development of the new medical school of the University of Birmingham.

DR. KARL L. MULLER, of the Forest Experiment Station at Munich, Germany, is spending several months in the Northern Rockies and the Pacific Northwest in search of the best climatic "race" of lowland white fir (*Abies grandis*) to meet the needs of southern Germany.

MR. MELBOURNE WARD, of the Australian Museum, is spending a few weeks examining crustacea at the National Museum. On November 15 he gave an illustrated lecture before the Biological Society on "The Natural History of the Barrier Reef of Australia."

DR. C. G. ABBOT, secretary of the Smithsonian Institution, delivered on November 22 a lecture before the Royal Canadian Institute, on "Studying the Sun in Many Lands."

ON the evening of December 2 at the University of Pennsylvania, Dr. Colin G. Fink, professor of electrochemistry at Columbia University, addressed the chemists and engineers of Philadelphia on "Combatting Corrosion with Chromium" covering in the main his researches of the last few years.

DR. ALBERT ERNEST JENKS, professor of anthropology, University of Minnesota, delivered an illustrated address on "Prehistoric Mimbres Culture" before a meeting on November 21, of the Sigma Xi Chapter of the Staff of Mayo Clinic, Rochester, Minnesota.

AT the autumn meeting of the Colorado Chapter of the Sigma Xi, held on December 12 in the recently completed Union Memorial Building of the University of Colorado at Boulder, Professor Etienne B. Renaud, of the University of Denver, delivered an address on the archeological survey of eastern Colorado conducted by him last summer.

DR. H. M. JOHNSON, head of the Simmons Investigation of Sleep at Mellon Institute, lectured at the University of North Carolina on November 5 and 6

on "The Logical Structure of Three Modern Psychologies" and on "Some Recent Experiments on Sleep." The lectures were given under the joint auspices of the university and the local chapter of Alpha Psi Delta, honorary psychological fraternity.

THE following lectures and clinics were given recently at the Duke University School of Medicine and Hospital: Professor M. Weinberg, of the Pasteur Institute, Paris, "Anerobic Infections and Serum Treatment"; Professor I. S. Ravdin, University of Pennsylvania Medical School, on "Diseases of the Gall Bladder," and Professor William Castle, of the Harvard Medical School, on "Deficiency Diseases in Relation to Anemias."

PROFESSOR JULIAN S. HUXLEY, honorary lecturer in King's College, London, and Fullerian professor of physiology in the Royal Institution, will deliver two lectures on biology at the New School for Social Research, New York, on January 8 and 15. The first lecture will deal with evolution; the second with problems of heredity and development. Following there will be a course beginning on January 2 of twelve lectures on "Modern Biology and Human Affairs," by Dr. Henry J. Fry, professor of biology at Washington Square College of New York University.

DR. ALBRECHT PENCK, professor of geography at the University of Berlin, was by invitation present at the celebration in London of the hundredth anniversary of the Royal Geographical Society. At its close he gave an address at the University of London on "The Relations between Europe and Central Asia."

THE American Mathematical Society held a regular meeting at the University of California at Los Angeles on November 29. An address was delivered by Professor H. F. Blichfeldt, professor of mathematics at Stanford University, on "The Method of Geometry in Numbers." Professor Harald Bohr, professor of mathematics at the University of Copenhagen, brother of Professor Niels Bohr, who is this year a visiting professor at Stanford University, spoke on "The Theory of Dirichlet Series."

THE North Jersey Section of the American Chemical Society meets at the Hotel Winfield Scott, Elizabeth, New Jersey, at 2:00 P. M., on Saturday December 13. Dr. Hugh S. Taylor will address the section on "Catalytic Reactions in Aliphatic Organic Chemistry." At the conclusion of the address buses will take members to the Bayway Refinery of the Standard Oil Company of New Jersey, where they will visit the technical service, research and motor laboratories. They will then return to the hotel where an informal dinner will be served. Two addresses will follow the dinner, the first by Dr. Warren K. Lewis on the "Thermal Properties of the Higher Hydrocarbons," and the second by Dr. R. P. Russell on "Hydrogenation of Oils."

THE thirty-eighth annual meeting of the American Psychological Association will be held from December 29 to 30 at the University of Iowa, Iowa City, under the presidency of Professor Herbert S. Langfeld, of Princeton University. Members of the association are to be guests of the university at a special dinner on Tuesday evening, December 30. At this time the new laboratory will be formally dedicated and a number of psychologists will speak on the status of experimental psychology.

THE Colorado-Wyoming Academy of Science convened for its fourth annual meeting in the University of Colorado at Boulder on November 28 and 29. All the important educational institutions in Colorado and Wyoming were represented and over a hundred scientific papers were presented in the various sections. Dr. H. H. Marvin, president of the Nebraska Academy of Science and head of the physics department of the State University of Nebraska, was the guest of honor and delivered the opening address on "The Approach to Unity of Explanation in Physics" and "The Raman Effect." Papers were presented by Professor R. G. Gustavson, of the University of Denver, on "The Female Sex Hormone," and by Josephine Roche, president of the Rocky Mountain Fuel Company, on "Social Science and Social Action." The following officers of the academy were elected for the coming year: *President,* Professor Frank E. E. Germann; *Vice-president,* Professor P. E. Boucher; *Secretary,* Professor J. Harlan Johnson; *Treasurer,* Professor O. M. Dickerson.

THE International Astronomical Union, of which Sir Frank Dyson, of London, is president, will have its annual congress at the Harvard Astronomical Observatory in the first week in September, 1932. Many astronomers will be drawn to America at that time by a total eclipse of the sun which will be visible in New England. That meeting will be the fourth congress held by the organizations. The others have been in Rome in 1922, in Cambridge, England, in 1925, and in Leyden in 1928.

THE Seventh International Conference of Industrial Psychology (Technopsychology, *Psychotechnique*), will be held in 1931 in Moscow, under the presidency of Dr. I. Spielrein, of the Institute for the Protection of Labor. While the date has not been definitely determined, it will probably begin on September 15. Industrial psychologists who wish further information may correspond with Dr. W. V. Bingham, 29 West 39th Street, New York, and Professor

M. S. Viteles, University of Pennsylvania, Philadelphia, American members of the council.

IT had been the intention, according to the *Journal* of the American Medical Association, to close the Internationale Hygiene-Ausstellung Dresden on October 12. In spite of bad weather, which cut down the attendance, nearly three million persons visited the exposition. But, in order to score the success in Germany and in foreign countries to which the exposition is entitled, a much greater attendance is needed. A large number of investigating commissions have visited the exposition. Since, in 1931, few, if any, large expositions are announced for Germany next year, the Dresden exposition will be opened again in 1931. The exhibit of modern hospitals and their equipment will be preserved complete. Many of the set-ups will be reorganized, and other set-ups entirely new will be added. Also the foreign exhibit, which is housed in the Staatenhaus, will be enriched by the addition of material, much of which, owing to the short time allowed for the preparation of the exposition of 1930, could not be assembled. A considerable amount of material from America has been promised. Another new set-up will be a general survey of Catholic missionary enterprises in foreign countries. To secure a large attendance of the public, a special and regular train service from all parts of Germany and from many points in foreign countries will be organized.

Industrial and Engineering Chemistry reports that an institute to popularize the study of chemistry, to aid in the development of chemical sciences and industries, has been established in the Soviet Union. The establishment will be known as the Museum Institute of the History of Chemistry and has been created upon the advice of the Higher National Economic Council. A credit of 15 million rubles (approximately $7,500,000) has been opened for the construction and development of the institute.

A GIFT of $2,500 for purposes of chemico-medical research at the Medical College of Virginia, Richmond, has been announced. At the request of the donor of the money his name has been withheld. This gift will make possible a full-time worker for one year in the department of chemistry. Other departments of the school of medicine will cooperate in plans already made for the special line of study to be undertaken and will share in the responsibility for the work as it proceeds.

THE correspondent of the London *Times* at Stockholm reports that Professor Hertzberg has made an examination of the films taken by the Andrée Expedition in 1897 and has achieved greater success than was anticipated with their reproduction, twenty of them giving perfectly clear pictures. Twelve of them will be reproduced in the official record of the Andrée Expedition. The best prints show the balloon after landing on the ice, from which it would appear that the loss of gas and the formation of ice on the envelope of the balloon caused it to come down. Another picture shows Andrée with a Polar bear he has shot, and this is so clear that the bear's fur stands out distinctly. In addition to pictures showing the wonderful spirit maintained by the party, there is one of the party's camp, but it is uncertain whether it was a camp on the ice or on Kvitö Island. It is noteworthy that some of the films on being developed show that they are positives. Professor Hertzberg states that the edges of the films in some rolls were found stuck together, thus hermetically sealing the center, and this, helped by the low temperature, preserved them.

A CAST of the fossilized skull and lower molar recently discovered at Chou Kou Tien, near Peking, has been presented to the British Museum (Natural History) by Mr. F. O. Barlow and is on view to the public in the Fossil Mammal Gallery at South Kensington for comparison with other skulls of primitive man. While the remains are of approximately the same age as those of the Ape-Man (*Pithecanthropus*) of Java, and the Piltdown man (*Eoanthropus*) found in the Sussex Weald in 1912, the juxtaposition of casts in same display-case now enables visitors to recognize the distinctions. The department of botany has received 152 natural-size water-colors of North American wild flowers from Mrs. Hosea B. Morse, who has enhanced the value of her gift by full botanical and biological notes.

Nature reports that an analysis of the literature of the Raman effect published up to the end of June of this year is given by S. Bhagavantam in the September number of the *Indian Journal of Physics*. Some three hundred and fifty references are dealt with—a large increase on the 150 listed by Dr. Ganesan last year in the same journal—and have been grouped under twenty-six heads, the first three of which contain book references and articles of a general character, and the remainder papers on special aspects of the effect. These are followed by an author index and an alphabetical list of the substances which have been studied, and there is a further list of almost a hundred other papers on light scattering which have been published by Indian authors since 1919.

INCREASED travel to the national parks during the past year is announced by Horace M. Albright, Director of the National Park Service. This heavier use of the national parks was the most remarkable when compared with the reduced use of transcontinental trains and of resorts generally. The national

park travel year ends on September 30 of each year. This year the number of visitors to the national parks totaled 2,818,618 as against 2,680,597 in 1929, an increase of 138,021. Yosemite National Park led in numbers, with 458,566 visitors. Mount Rainier was second, with 265,620. The national monuments as a whole suffered a loss, with 466,075 visitors as against 567,667 in 1929. A large part of this decrease, however, was the result of the abolishment last April of the Papago Saguaro National Monument, which last year reported 87,600 visitors. During the first six months of this year, the period of heaviest travel in the southwest, approximately 50,000 people visited this monument. The Petrified Forest National Monument in Arizona, with 105,433 visitors, led both in numbers and in point of increase. The 1929 visitors to this monument numbered 69,350. Director Albright was enthusiastic over the development possibilities of the area. Despite the reduction in the number of visitors to the monuments, the combined park and monument travel for 1930 is greater than that for any previous year with the exception of 1929.

THE council of the British Association have asked the government to give effect to the recommendations of the Royal Commission on National Museums and Galleries for the establishment of a National Open-Air Folk Museum. It is suggested that the Royal Botanic Gardens in Regent's Park could be utilized.

THE London *Times* reports that an expedition from the University of Cambridge is sailing for Mombasa early in December to carry out biological investigations of certain little-known lakes in East Africa. The particular objectives will be Lake Rudolf, Lake Baringo and Lake Edward. Several expeditions have been made to the better-known lakes, and in 1927 government surveys of the Victoria and Albert Nyanzas were made to investigate the economic value of native fishes. Lakes Rudolf, Baringo and Edward have never been scientifically examined, and it is expected that the expedition will bring home a large number of new forms of life, as well as information about the inter-relationships of the fauna and flora, about the chemistry and physiography of the lakes, and perhaps a solution of the interesting problem of the absence of crocodiles from Lake Edward. Another side of the work will be the extension of Mr. L. S. B. Leakey's recent Kenya archeological explorations northwards in the Great Rift Valley; it is hoped to find further archeological remains round Lakes Baringo and Rudolf. The expedition is being financed by the Royal Society, the Natural History Museum, the Royal Geographical Society, the British Association and other scientific bodies. It will be under the leadership of Dr. E. B. Worthington and other members from Cambridge will be Mr. L. C. Beadle as zoologist and Mr. V. E. Fuchs as geologist and surveyor.

DISCUSSION

BABYLONIAN MATHEMATICS

ALL the earlier accounts relating to the historical development of the quadratic equation have become antiquated during the last two years as a result of recent discoveries relating to the mathematical attainments of the Babylonians during a period of at least 1,500 years beginning about 2000 B. C. It is especially interesting to observe that this period overlaps that of the early Greek mathematical activity and hence it establishes a continuity in algebraic developments which had not been known to exist hitherto. According to a recent number of the *Quellen und Studien zur Geschichte der Mathematik*, a new publication to which Professor R. C. Archibald called attention in this journal,[1] we now know at least 19 Babylonian problems which give rise to quadratic equations, and with respect to 10 of these the details of the solutions are given. In some cases the method used corresponds to the modern method of completing the square and differs only from our modern procedure by omitting the double sign when the square root is extracted.

The Babylonian mathematics is of special interest in view of the fact that our division of the circle into 360 parts called degrees, and our division of the degree and the hour into 60 parts called minutes and of the minute into 60 parts called seconds can be traced back thereto. It has often been stated that the Babylonians employed a sexagesimal system of numerical notation. As a matter of fact this is not strictly true since they did not employ 59 different symbols for the first 59 natural numbers; neither did they employ a sexagesimal symbol corresponding to our decimal point to mark the starting-point of their integral numbers and their systematic fractions represented by multiples of negative powers of 60. A fully developed sexagesimal system of numerical notation has never been commonly used as far as we know. The early Babylonians do not seem to have possessed even an emptiness zero, but a symbol which was also used as a symbol of separation was employed later by them for this purpose.

[1] SCIENCE, 70: 67, 1929.

Since the Babylonians commonly employed only two distinct symbols to represent the first 59 natural numbers, *viz.*, a symbol for unity and a symbol for ten, their system of numerical notation can be more properly called a decimal system than a sexagesimal system. There is, however, a very striking difference between their system of notation and the systems employed by the other early nations, since their symbol for unity was used also to represent various positive and negative powers of 60, depending upon the relative positions, which are, however, frequently not clearly exhibited in their notations. Hence we meet here for the first time in the history of mathematics an approach to our modern positional notation where the same symbol is used to represent an infinite number of different numbers depending upon its position relative to the decimal point, either implied or expressed. When multiples of negative powers of the base are used to represent fractions, a symbol of separation, corresponding to our decimal point, is almost as important as an emptiness zero symbol, but the former has received much less attention on the part of mathematical historians than the latter.

In the periodical noted above Professor O. Neugebauer, of Göttingen, Germany, stresses the fact that the ancient Babylonians did not have a fully developed positional system of numerical notation but that it is likely that our modern system to the base 10 was influenced by their steps in this direction. In view of the fact that they made such important progress towards the solution of the general quadratic equation one might have expected that they would have easily mastered the simpler problem of completing their positional arithmetic by means of a symbol corresponding to our decimal point and by a much earlier and more common use of a symbol for an emptiness zero. The great importance of these apparently easy forward steps may be seen if it is noted that the translation of the numerical notations now frequently presents the greatest difficulties to the students of the ancient Babylonian literature. Just where one might have expected the greatest clearness one finds the greatest vagueness.

We are thus brought face to face with the fundamental fact of the history of mathematics—that unexpectedly advanced results are frequently found side by side with very crude ancient developments. It is therefore often very difficult for the mathematical historian to convey a correct picture of the actual attainments at a certain period of time. Naturally the most advanced developments are usually first considered and hence the beginner is apt to think too highly of the attainments of the ancient civilizations. The solutions of the quadratic equations to which we referred above are, however, also of great interest since they tend to exhibit the naturalness of this equation in our efforts to secure an intellectual penetration into our surroundings and hence they tend to dignify this equation as an intellectual tool. They also tend to emphasize the fact that mathematical history is a subject that must be frequently revised in order to be up to date even as regards very elementary results.

G. A. MILLER

UNIVERSITY OF ILLINOIS

A FOSSIL FROG, INDOBATRACHUS NOBLE, FROM THE EOCENE OF SOUTHWESTERN INDIA

A FEW months ago G. K. Noble[1] reported upon his study of a number of specimens of a fossil anuran which, from the geographical locality and geological horizon as well as general resemblance to the descriptions, seems to be what was first named *Rana pusilla*,[2] later called *Oxyglossus* by Stoliczka,[3] now *Oxydozyga*.[4] Noble regards the form as an "archaic bufonid" closely related to the "archaic bufonids" found to-day in Australia. Noble writes, "The discovery of a toothed bufonid in the Eocene of India lends support to the theory of a northern origin for the Australian frog fauna."

Noble's "toothed bufonids" now living in Australia are regarded as Leptodactylids by other herpetologists. These apparently arose in South America from true bufonids. The family Bufonidae may, for convenience, be divided into two divisions, the first including archaic forms of pre-Cretaceous or early Cretaceous origin in southern lands and belonging to genera other than *Bufo;* the second division including only the comparatively modern genus *Bufo,* which probably evolved in southeastern Asia in the Cretaceous period. The genera of the first division occur to-day in Australia, in northern South America, in Java and Borneo, Ceylon, southern India and in tropical Africa. From ancient bufonids evolved apparently: (1) *Bufo,* in southeastern Asia—*Aelurophryne* seems an intermediate form from this general locality. *Bufo* has spread to all parts of the world accessible since, say, the middle Cretaceous; (2) the Hylidae arising apparently in the Guiana-Brazil highlands after they united with the Ecuadorean island; (3) the Lepto-

[1] G. K. Noble, "The Fossil Frogs of the Intertrappean Bed of Bombay, India," *Am. Mus. Novitates,* No. 401, February 8, 1930.

[2] Owen, "On the Batracholites Indicative of a Small Species of Frog (*Rana pusilla,* Owen)," *Quart. Journ. Geol. Soc., London,* III, 1847.

[3] Stoliczka, "Osteological Notes on *Oxyglossus pusillus* (*Rana pusilla,* Owen) from the Tertiary Frog-beds in the Island of Bombay," *Mem. Geol. Survey India,* VI, 1869.

[4] "Kuhl," quoted by Tschudi in synonomy of *Oxyglossus, Mem. Soc. Sci. Nat. Neuchatel,* II: 85, 1838.

dactylidae, arising perhaps further south, in Patagonia, and spreading by way of Antarctica to Australia. But these three families so merge into one another that intermediate forms, especially fossil, may be difficult to assign. *Indobatrachus,* from its distribution, would seem to be a true archaic bufonid rather than a Leptodactylid.

The presence of *Indobatrachus* in the Eocene of southwest India has to me a different meaning from that indicated by Noble. During the Triassic period the great southern continent which I have called Equatoria (Gondwanaland[5] plus South America) apparently included southern India. So also, according to usual opinion, did the more restricted Jurassic continent, Gondwanaland. The presence of one of the more archaic genera of Bufonidae in the Eocene of southern India seems to show merely that one of these ancient bufonids, all of southern origin, persisted until Eocene times in northern Equatoria, or rather in a persistent fragment of this old southern continent, a fragment which has now established connection with northern land after the disappearance of the water channels of the archipelago which once lay between them.

To the biogeographer the word continent implies a region of free faunal and floral interchange. It is important to treat the biotic evidence with full tentative initial acceptance, slurring none of it, but giving frankly the conclusions to which it would most naturally lead. Such conclusions from the biotic data are then open to criticism from all germane sources. A well-nigh overwhelming mass of biotic data seems to point convincingly to faunal and flora interchange during Mesozoic or early Tertiary time between the southern continents, interchange which was itself southern and not by way of any northern lands. The familiar mammalian data indicating chiefly northern origin and southward distribution of mammals in the Tertiary do not militate against the general biotic evidence for pre-Tertiary or early Tertiary east and west communication between the southern continents. Indeed the biotic data show a sub-Antarctic fauna and flora in Antarctica, the sub-Antarctic islands, Australia, New Zealand, southern South America and, to a less extent, Africa, which seems as truly a unit as is any other faunal and floral unit. South Africa's connection was apparently not of long duration.

M. M. METCALF

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[5] The name Gondwanaland has been applied by some authors to the Jurassic continent, Australia plus southern India plus the Indian Ocean Lemuria, including Madagascar, plus Africa. Others have applied the name Gondwanaland to this great southeastern land mass plus its Triassic extension to the west across the Atlantic Ocean and including South America. I have used the name Equatoria for this larger, Triassic continent, thus avoiding ambiguity.

NEW TYPES OF PLANTS IN FLORIDA

FLORIDA, being practically isolated by large bodies of water from other countries having a similar climate, was probably quite slow to acquire tropical and subtropical forms of plants till man intervened. Since that event, however, new types have appeared in the state with increasing frequency, taking their place among the native vegetation. One such accession, *Cassia rotundifolia* Pers. or *Chamaecrista rotundifolia* (Pers.) Greene, was discovered in June, 1930, on the grade of a branch line of the A. C. L. Railroad which runs from St. Petersburg, Florida, to Sanford, Florida. So far as I can learn this plant grows nowhere in the United States, except for a distance of not more than 500 feet on the railroad embankment near Palm Springs, about three miles west of the town of Longwood, Florida, where it grows vigorously and fruits abundantly.

From my examination I am unable to make this species fully conform to the published descriptions of either *Cassia* or *Chamaecrista.* It possesses the distinctive leaf and stamen characteristic of *Cassia.* It is also but slightly sensitive and is without leaf glands. On the other hand, the single axillary flower on a twisted peduncle, the slightly unequal petals and the distinctly flat pods are features possessed by *Chamaecrista.* It may possibly deserve to be given a new genus name.

Conjecturally, one may readily account for the presence of the plant where it was found. It is a native of Mexico and the seeds may easily have been included with the packing of a boat shipment to some of the ports around Tampa Bay; from there by train to their destination on the railroad in Seminole County.

Solanum jamaicense was first brought to the U. S. D. A. Laboratory, at Orlando, Florida, about June 15, 1930, by Messrs. W. H. Pope and W. D. White, wild host scouts searching for hosts of the Mediterranean fruit fly. In a letter from Dr. A. Wetmore, of the National Museum, he states that this species had not formerly been reported as growing in the United States.

The plant was found near St. Cloud, about 25 miles to the southeast of Orlando. A visit to the locality was made on July 19 and the *jamaicense* was found growing in considerable numbers on a slight rise along the margin of what is called East Lake. The elevation is not more than 8 or 10 feet above the high-water level of the lake, and the ridge is about 100 yards wide by 2¼ miles long and lies between the lake and a slough. There is no indication that the location has been a house site, and the nearest house is now more than one half mile away. Trees and shrubs, such as *Tamala humilis, Acer floridanum, Ilex*

cassine, Ilex glabra, Morella cerifera, Vitis rotundifolia, Taxodium distinctum, etc., form a dense growth over most of the area and appear to be many years old. The *Solanum* grows around the edge of the denser portion of the vegetation. The *jamaicense* seems to be thrifty in the habitat and fruits abundantly and when last seen bore all stages from bloom to ripe berries.

Aeschynomene americana L. has been observed growing and seeding profusely in waste low pine in Orange, Polk and Hillsborough counties, Florida. It seems well suited to the new environment.

MAURICE MULVANIA
ORLANDO, FLORIDA

DREIKANTER IN WYOMING AND MONTANA

WHILE engaged in geologic work during the past summer in company with Dr. C. K. Wentworth, associate professor of geology, Washington University, St, Louis, the attention of the writer was called to several occurrences of dreikanter or wind-etched pebbles in Wyoming and southern Montana.

Text-books generally tell us that dreikanter are found in desert areas where there is an abundant supply of loose sand. With this conception in mind, the occurrence of the dreikanter found during the past summer is doubly interesting.

The most perfect examples of dreikanter were found on the western slope of the Wind River Mountains in western Wyoming. Here is an ancient land surface, apparently undisturbed during recent geologic time, with a relief low enough to allow for the free sweep of the wind. The pebbles were partly buried, with the upper etched portion protruding from the ground. Many finely polished specimens with the three angular edges so characteristic of true dreikanter were found at this locality. Far exceeding these in number were those showing only one well-developed angular edge (Einkanter), and others in which the upper portion of the pebble had been removed by the sand-blast action. The average size of the pebbles was about that of a lemon, although many larger specimens were found. The largest seen was a very well-developed dreikanter boulder which measured 24 inches long, 16 inches high and about 14 inches wide.

Another Wyoming locality between Rawlins and Medicine Bow yielded numbers of wind-etched cobbles of various sizes. Here the shaping of the individual cobbles had not progressed to completion, but a large proportion of the boulders studding the surface showed definite evidence of sand-blast action, many of them with characteristic einkanter shape. Wind-etched cobbles were also found in the neighborhood of Bosler, Wyoming.

The surface of terraces in the valley of the Yellowstone River east of Livingston, Montana, were found to contain numbers of etched cobbles, only a few of which showed a definite shaped dreikanter profile. Here, as elsewhere, were found many einkanter, but these were far outnumbered by fragments showing only partial etching and shaping.

It is interesting to note that at none of these localities does the country show true desert characters. All are in areas of scanty rainfall and sparse vegetation, but the amount of loose sandy material is small. Again, it may be worthy of mention that the better shaped cobbles were found in localities where the ground was not too thickly studded with rock fragments.

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DEMONSTRATIONS IN CYTOLOGY

THE teaching of cytology requires abundant microscopic demonstrations to acquaint the student with factual evidence of the different topics discussed in the lectures. At the present time cytologic investigation is so diversified and specialized that it is impossible to prepare adequate material for this purpose. To overcome this difficulty, the writer proposes to establish a mutual exchange of slides among the many investigators in cytology. The following plan is submitted as a tentative procedure.

(1) The writer offers to exchange preparations of polar body formation, fertilization, segregation of germ-cells and cleavage stages up to blastoderm formation in *Drosophila melanogaster* and Cerebratulus for any other preparations of great cytologic interest.

(2) From the slides thus received the writer will select some for his own collection and offer the remainder to all others who are interested on the basis of mutual exchange. Slides will be itemized on a mimeographed list.

The writer discussed this proposition with several cytologists in Woods Hole this summer and it was approved by all. Most investigators have duplicate preparations or some which can not be used in their work but would serve a useful purpose in general cytology. Instead of discarding such preparations, they should be put into service to demonstrate cytologic phenomena.

Teachers of cytology who wish to cooperate in this mutual exchange should label the slides carefully, and if the point of interest is limited to a small field, the area should be marked.

ALFRED F. HUETTNER
WASHINGTON SQUARE COLLEGE,
NEW YORK UNIVERSITY

SPECIAL CORRESPONDENCE

THE RUMFORD FUND

THE Rumford Fund of the American Academy of Arts and Sciences was established by Benjamin Thompson, Count Rumford, physicist and administrator, through a gift of five thousand dollars to the American Academy, in July, 1796, for a medal or premium to be awarded at regular intervals to authors of the most important discoveries or useful improvements in light and heat, in any part of the continent of North America or in any of the American islands.

The American Academy had, in the earlier years, certain difficulties in administering the fund, and applied, in 1831, to the Supreme Court of the Commonwealth of Massachusetts for instructions. The court issued a decree which enabled the academy to apply part of the income from the fund for grants to researchers in light and heat. Since 1833, the academy has maintained a standing committee of seven fellows, known as the Rumford Committee, which makes recommendations to the council for the award of the Rumford Premium, and also makes grants to suitably qualified researchers in light and heat.

The thirty-five recipients of the Rumford Premium to date, commencing with the first award in 1839, have been Hare, Ericsson, Treadwell, Clark, Corliss, Harrison, Rutherford, Draper, Gibbs, Rowland, Langley, Michelson, Pickering, Edison, Keeler, Brush, Barus, Thomson, Hale, E. F. Nichols, Acheson, Wood, Curtis, Crafts, Ives, Stebbins, Coolidge, Abbot, Bridgman, Lyman, Langmuir, Russell, Compton, E. L. Nichols and Plaskett.

The Rumford Committee has also made more than two hundred and eighty grants of money, ranging from $25 to $500, to researchers, the average amount since 1839 having been about $270. These grants are for apparatus, materials or experimental equipment, but not for the payment of assistants. They are also made towards the printing of researches on light and heat, subjects in which Count Rumford was particularly interested. More recently, however, the subject of X-rays has been accepted by the committee as coming within the scope of the fund.

Persons making application for grants from the Rumford Fund are expected to inform the committee of the nature and method of the research, so that a clear judgment can be formed as to whether it comes within the scope of the fund; also as to whether any similar applications have been made for grants from other funds for the same research. Researches aided by the Rumford Fund may be published in any place or form, with the proviso that due recognition be made therein as having been aided by the fund. A complete copy of each such publication should be presented to the academy.

Applications for grants should be addressed to the Chairman, Rumford Committee, American Academy of Arts and Sciences, 28 Newbury Street, Boston, Mass. Such an application may be made by any duly qualified person in North America, or any of the American islands. It should specify the nature of the research and the pecuniary amount desired.

A. E. KENNELLY,
Chairman of the Rumford Committee

QUOTATIONS

THE WORK OF DR. KARL LANDSTEINER

KARL LANDSTEINER, since 1922 a member of the Rockefeller Institute for Medical Research in New York, is the recipient of the 1930 Nobel Prize in medicine. Since the beginning of his scientific career, more than thirty years ago, Landsteiner has made contributions of great significance to medical science. He has thrown much new light on the nature of paroxysmal hemoglobinuria. With Popper he first produced infantile paralysis in the monkey, a demonstration that was followed by the intensive experimental work to which we owe practically all that is known of the nature of the causative agent of the disease. Undoubtedly Landsteiner's greatest and most brilliant work is his study through many years of fundamental problems in immunity, particularly the chemistry of the specificness of immune reactions. In this field, that is, the relations of the mechanisms of immunity to chemical structure, he has been and is a great leader, making no hasty or extravagant claims but standing always on solid ground. The main motivation for awarding to him the Nobel Prize in medicine appears to have been his discovery of the human blood groups or the phenomenon of iso-agglutination. His first statement about human iso-agglutination appears in a footnote to an article in 1900 about the antifermentative, lytic and agglutinating actions of the blood serum and lymph. In this footnote he says that the serum of normal persons agglutinates not only the blood corpuscles of animals but also the corpuscles of other persons. It remains, he continues, to determine whether this phenomenon depends on natural, individual differences or on injurious influences perhaps of bacterial nature. In fact, he had found the action especially pronounced in blood from patients with severe diseases. Before long he demonstrated conclusively by careful observations that iso-agglutination depends on individual, physiologic differences in the blood. Here was a concrete and clean-cut discovery that was destined to have wide applica-

tions. Landsteiner himself early pointed out the possibility that iso-agglutination might prove of importance in the identification of blood for medicolegal purposes and also in blood transfusion. The practical use of blood grouping, now universal, to exclude incompatible donors in therapeutic transfusion was initiated and developed especially in this country. When it became established that the factors on which blood grouping depends are transmitted according to the laws of heredity, determination of the blood groups was applied to the study of interracial relationships and of problems of parentage. When Landsteiner described the blood groups, he was an assistant under Weichselbaum in the pathologic-anatomic institute of the University of Vienna. No doubt he little thought then that that work was to bring him such rich reward thirty years later, but he did the work and carried out the observations as carefully and accurately as he could without any consideration or motive other than to find out all in his power about something new and obscure. Thus his work became the starting point in a series of advances in knowledge and achieved its international and well-merited recognition.—*The Journal of the American Medical Association.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ELECTROMAGNETIC TOUCH-STIMULUS REACTION KEY

FOR laboratory investigation of tactual reaction time, the author has constructed and employed with success at the Florida State College for Women an electromagnetic touch-stimulus reaction key which can be controlled at a position remote from the recording chronoscope. The apparatus described below is an improved form of the author's original key. The extended rocker of the original key was provided with an elongated terminal perforation through which a metal rod was activated vertically by means of the armature of a modified electromagnetic sounder. By substituting linear solenoid motion for the leverage armature motion which characterized the earlier model, any angular displacement of the plunger rod is completely eliminated.

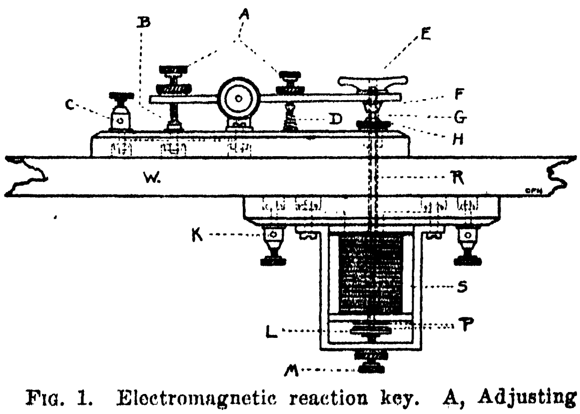

FIG. 1. Electromagnetic reaction key. A, Adjusting screws. B, Platinum contact. C, Binding post. D, Brass resistance spring. E, Rubber finger knob with circular hole in center through which plunger rod passes. F, Heavy platinum contact. G, Hard rubber plunger rod. H, Adjusting screw which serves as binding post. K, Binding post connecting electromagnet. P, Thin felt cushions. S, Magnetic coil wound with 22 B.S. gauge double cotton covered wire. R, Plunger rod passing without contact through table top. L, Soft iron plate to which plunger rod is affixed. M, Adjusting screw to vary the distance between plunger plate and magnet core.

The reaction key (Fig. 1) is simple in design and is substantially constructed of hard brass to withstand considerable laboratory use and punishment at the hands of the beginner. The reaction key is employed in conjunction with the Heinlein duo-circuit stimulus key. The latter key, consisting of two conjoined but mutually insulated parallel rockers balanced on a single fulcrum, acts as a nicely adjusted double-pole single-throw circuit breaker. Both reaction and stimulus keys are inserted in the conventional Dunlap chronoscope circuit. The complete electrical hookup is indicated in Fig. 2.

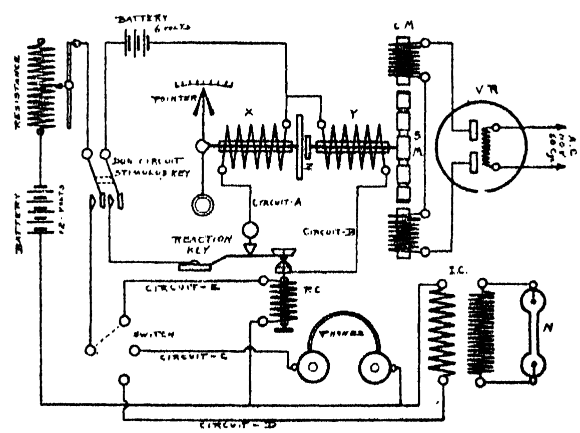

FIG. 2. Chronoscope hookup. X, External clutch coil. Y, Internal clutch coil. Z, Clutch plates. SM, Armature of synchronous motor. CM, Motor field pole. VR, Valve rectifier. PC, Plunger coil of touch reaction key. IC, Induction coil. N, Neon tube.

When the finger knob of the duo-circuit stimulus key is depressed, through completion of the primary and secondary circuits, both the internal electromagnetic coil of the chronoscope friction clutch and the electromagnetic coil of the touch-stimulus reaction key are simultaneously activated. If the internal resistance, magnetic affinity and working load of each electromagnetic coil are approximately the same, the

dynamic lag characteristic of the first coil should approximately equal the dynamic lag characteristic of the second coil. Any existing lag difference will not vitiate accurate timing provided that the extent of such lag difference is determined, since the existing difference itself is a constant when the parallel circuit E.M.F. is constant.

In actual experimentation, the director first presents to the subject a "get ready" signal by depressing a special circuit key which may either illuminate a small tungsten lamp or activate a high frequency buzzer. This preliminary signal is afforded for the purpose of informing the subject just when to place his finger on the concave cushion knob of the reaction key. After an appropriate interval, the time value of which may be controlled by a seconds pendulum and varied at the discretion of the director, the experimenter then depresses the duo-circuit stimulus key. Depression of the reaction key followed by depression of the stimulus key closes circuit B (Fig. 2), thereby forcing the plunger rod through the finger knob aperture of the reaction key simultaneously with the initial movement of the pointer on the time dial of the chronoscope. The subject has been previously instructed to release his finger from the reaction key the instant that he perceives the plunger rod touch his skin. Release of the reaction key by the subject provides a circuit transfer from B to A which magnetizes the external coil X of the chronoscope clutch and thus attracts the dial pointer outward to a state of rest. Since a valve rectifier (VR) is inserted between the synchronous motor of the chronoscope and the alternating circuit main, the conventional 60-cycle input is converted into a 30-cycle input (sixty impulses per second) which provides a dial measuring unit of one six-hundredth of a second. According to Dunlap, a measuring unit of two sigma is small enough for practical purposes. The investigator should never utilize alternating current that is not centrally synchronized.

If the experimenter wishes to investigate reaction time to auditory and visual stimuli in addition to reaction time to touch stimuli, the necessary apparatus adequate to provide such sensory stimulation may be inserted in the same chronoscope circuit without difficulty. A three-point switch shifts the stimulus control current from the plunger coil (circuit E) either to a pair of 2,000 ohm headphones (circuit C) or to an induction coil which is directly connected with a neon lamp (circuit D). The same reaction key may be used for each of the three types of presented stimuli.

CHRISTIAN PAUL HEINLEIN
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A METHOD TO SOFTEN TISSUE ALREADY IMBEDDED IN PARAFFIN[1]

THE method is believed to be generally applicable. It was first tried by the writer on lily ovary tissue in Professor W. C. Coker's laboratory at the University of North Carolina. The most convincing results, however, have just this summer been obtained while doing histological work on the pineapple leaf.

The pineapple leaf in a fresh condition, though rigid, is not particularly tough. In paraffin it is definitely brittle, and without softening treatment the tissue crumbles on the knife instead of cutting.

The following method has been used very successfully in obtaining smooth, even and straight paraffin ribbons of sections of pineapple leaf.

1. Rectangular pieces of leaf not over 4 by 10 mm, preferably smaller, are fixed in FAA. The pineapple leaf varies in thickness from less than 1 mm to about 2 mm.

2. Dehydrate and clear in the usual way with ethyl alcohol and xylol.

3. Infiltrate and imbed in paraffin. Infiltration must be as nearly perfect as possible. Paraffin of melting-point 52°–54° C. has been used on account of lack of that of 56°–58° C., which it is believed would be better suited for our laboratory temperature range of 27°–29° C. during the daytime. At this temperature sections could not be cut continuously successfully at less than 12 μ.

4. Shape the imbedded tissue ready for cutting. Trim the two edges and one end so that the leaf tissue will be directly exposed. This is very necessary to facilitate the subsequent treatment. If the piece is long, both ends may be exposed. Drawing the edge of a sharp, thin razor blade across the surface of the paraffin block to which the leaf tissue is nearest will also help, but is not necessary unless large pieces are used.

5. Store in 95 per cent. alcohol (at a temperature of about 30° C.) containing enough carbol fuchsin to make it pink. If material turns red throughout when transferred to water containing a little carbol fuchsin, infiltration was not complete. Such material will not cut satisfactorily. Paraffin is very slightly soluble in 95 per cent. alcohol at 28°–30° C.

Two to 4 days is sufficient to make the younger leaf tissue cut satisfactorily. Two to 3 weeks improves it and is necessary for the older leaf tissue.

6. Transfer to water 2 to 24 hours before trying to cut.

7. If, after half a block has cut well, the ribbon

[1] Since this announcement went to press, more definite results have been obtained and will be published later. The work is being continued in the Botanical Laboratory of Johns Hopkins University.

begins to twist and fold, place the material in water again.

The method is not recommended for tissue which is tough in a fresh condition, nor will it take the place of a sharp knife. The writer prefers a regular microtome knife, stropped at frequent intervals, to any of the razor blade holding devices. Investigations are to be continued along this line to find a water or alcohol soluble substance which has greater softening qualities than pure water that can be used successfully in connection with the 95 per cent. alcohol treatment to soften tissue which is definitely tough in a fresh condition.

Chamberlain recommends a method used by Dr. Land of storing the paraffin cakes in water. The writer is not in a position to make comparisons. Obviously, however, the 95 per cent. alcohol treatment upon the partially exposed material would facilitate the infiltration of water later. It is hoped that this modification of Dr. Land's method may meet with some favor among paraffin workers.

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SPECIAL ARTICLES

IMMUNIZATION WITH ALUMINUM HYDROXIDE MIXTURES OF POLIOMYELITIS VIRUS

THE recrudescence of poliomyelitis in the United States and Europe during the past two or three years has led to a restudy of the disease from many points of view. This brief report deals with the experimental evidence that the virus of poliomyelitis, inactivated by adsorption on particles of aluminum hydroxide, is still capable of producing immunity when inoculated into *Macacus rhesus* monkeys. Previously several investigators had shown that a variety of viruses could be adsorbed and rendered ineffective by a number of colloidal and particulate chemical substances. No one seems, however, to have tested the inactivated materials for the production of artificial, active immunity.

The aluminum hydroxide employed was the type C suspension of Willstätter containing 22.5 grams of aluminum per liter. The virus was either Berkefeld N filtrate of fresh monkey pooled virus,[1] or suspension of glycerolated material of the same strain. Mixtures of virus and suspension were allowed to stand 30 minutes at room temperature. The experiments carried out were of three types: simple observations on the inactivation of poliomyelitis virus by aluminum hydroxide; studies of the effect of the pH of the mixture on the inactivating power; and determinations of the value of the inactivated virus in the production of immunity. Intracerebral inoculations of the aluminum suspension alone were without pathological effect.

In respect to these three tests it was found first, that the filtrate and aluminum hydroxide mixed in equal volumes became inactive; second, that inactivation was promoted by acid (5.5) and prevented by alkaline (8.8) reactions; and third, that repeated subcutaneous injections of the inactivated virus led to active immunity.

[1] Rhoads, C. P., *Jour. Exper. Med.*, 49: 701, 1929.

The immunity thus induced was tested in three ways. First, glycerolated virus was repeatedly instilled into the nostrils. All the previously treated animals resisted infection, although the control developed typical poliomyelitis. The second test, carried out 28 days after the first, consisted of intracerebral inoculation of fresh virus. Of three treated animals so tested, one developed poliomyelitis, as did the control, and two resisted infection. The third test was made with the blood serum of the treated monkeys. Each of the three sera was tested separately and each neutralized the virus.

It may, therefore, be concluded that the virus, when adsorbed on aluminum hydroxide, is incapable of producing poliomyelitis, but still capable of inducing active immunity in *Macacus rhesus*. In a small series of animals thus immunized, no symptoms of experimental poliomyelitis arose, and in one only was the degree of immunity, although adequate to protect against nasal instillation, insufficient to protect against intracerebral injection of virus. That all three treated monkeys developed immunity is shown by the serum neutralization tests.

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THE EFFECT OF TESTICLE EXTRACT AND NORMAL SERUM ON THE GROWTH OF A TRANSPLANTABLE EPITHELIAL TUMOR OF THE RABBIT[1]

EARLIER investigations in this laboratory[2, 3] have shown that extracts of the testes considerably enhance

[1] From the laboratories of the Rockefeller Institute for Medical Research.

[2] F. Duran-Reynals, *Soc. Biol.*, 1928, 99, 6; *J. Exp. Med.*, 1929, 50, 327.

[3] F. Duran-Reynals and J. Suñer Pi, *Soc. Biol.*, 1928, 99, 1908.

the infectivity of vaccine virus and staphylococcus, while blood serum interferes with the action usually observed with these agents. These observations have been extended by Hoffman,[4] who has demonstrated the same phenomena with other filterable viruses and by Pijoan[5] with many other bacteria.

The present report deals with the effect of testicle extract and serum on the Brown-Pearce rabbit tumor,[6] a malignant, transplantable neoplasm of epithelial origin. In each experiment, three sets of test inoculations were made as follows: A suspension of the tumor cells was made with (a) an equal volume of testicle extract, (b) an equal volume of normal rabbit serum, (c) an equal volume of Ringer's solution as a control. These mixtures were incubated for 2 to 3 hours at a temperature of 37° C. and then injected intradermally in the shaved skin of the side of the body. Each rabbit was inoculated in one or more areas with each test mixture.

The results obtained in 10 rabbits inoculated in 84 different areas are shown in the accompanying table.

TABLE I

Effects of Testicle Extract and Serum on the Brown-Pearce Tumor

Tumor cell suspension plus	Number of inoculations	Larger growth than control	Same growth as control	Smaller growth than control	No growth
Rat testicle extract	16	0	0	2	14
Rabbit testicle extract	16	0	1	6	9
Rabbit serum	32	19	10	3	0
Ringer's solution (control)	20				0

In addition, an experiment carried out with the intratesticular inoculation of tumor tissue and rat testicle extract resulted in a less active primary growth and a greatly decreased distribution of metastases as compared with the results obtained by the intratesticular inoculation of suspensions prepared with Ringer's solution. This result is an apparent paradox, for the method used in carrying this tumor is by intratesticular injection, with which active growth is usually associated.

It may be concluded from these experiments that testicle extract exerts an inhibitory effect on the growth of a transplantable rabbit tumor, while normal rabbit serum, on the contrary, appears to stimulate its growth. These findings are in contrast to those obtained with viruses and bacteria, in which the testicle extract augments and normal serum inhibits the effects of these agents.

F. Duran-Reynals

[4] D. C. Hoffman, *J. Exp. Med.* (in press).

[5] M. Pijoan, *J. Exp. Med.* (in press).

[6] W. H. Brown and L. Pearce, *J. Exp. Med.*, from 1923 to 1929.

THE NECESSITY AND FUNCTION OF MANGANESE IN THE GROWTH OF CHLORELLA SP.[1]

The importance of manganese in plant growth has been emphasized by the experiments of McHargue,[2] and more recently Samuel and Piper[3] have shown very clearly its essential nature for a fairly large number of species of seed plants. In the experiments of the latter workers practically no development of the plants beyond the seedling stage was obtained without manganese. Titus and Cave[4] have also shown the beneficial effect of manganese in hemoglobin building in the cases of animals made anemic on a whole milk diet. The necessity of manganese for a single-celled organism has not been shown and is of fundamental importance.

In connection with my own studies on iron in relation to Chlorella sp., a unicellular green alga, it has also been found that manganese is essential for growth. Increases of from 10 to 600 fold in the growth have been obtained by the addition of one part of manganese in five million parts of culture solution from which the manganese had been removed by adsorption on calcium phosphate. The accompanying tables present the data from two experiments which are typical of many performed. The experiments were carried out in pure culture.

TABLE I

The Necessity of Manganese for the Growth of Chlorella sp.

pH 7.0			pH 8.0		
Cult no.	Manganese	Dry weight	Cult no.	Manganese	Dry weight
1	none	2.6 mgs	9	none	0.6 mgs
2	"	5.1	10	"	0.4
3	"	2.2	11	"	0.2
4	"	0.9	12	"	0.1
5	1: 5,000,000	58.7	13	1: 5,000,000	77.2
6	"	57.1	14	"	45.7
7	"	64.7	15	"	52.8
8	"	60.3	16	"	53.2

The results shown in Table I demonstrate the necessity of manganese for Chlorella sp., since there is practically no growth without it. At pH 7.0 the increase due to manganese is about 17 fold and at pH 8.0 about 170 fold. The fact that there is more

[1] The investigation upon which this article is based was supported by a grant from the Heckscher Foundation for the Advancement of Research established by August Heckscher at Cornell University.

[2] *Ind. and Eng. Chem.*, 18: 172–175, 1926.

[3] *Ann. Appl. Biol.*, 16: 493–524, 1929.

[4] Science, 68: 410, 1928.

TABLE II

THE EFFECT OF CONCENTRATION OF MANGANESE ON THE GROWTH OF CHLORELLA SP.
pH 8.0

Concentration manganese	0	1 to 5,000,000	1 to 1,000,000	1 to 500,000	1 to 100,000	1 to 50,000
Dry weight mgs. av.	1.4(4)*	52.9(4)	53.7(4)	48.1(4)	36.2(3)	11.9(3)

* The figures in parenthesis refer to the number of cultures included in the average.

growth without added manganese at pH 7.0 may be due either to the difficulty of completely removing the manganese impurity or to the greater ionization of the manganese at this reaction.

In Table II the toxicity of manganese is also shown as the amount added is increased. It should be stated that to each culture of the above experiments was added 0.1 mg of iron and 0.04 gms of sodium citrate, and therefore soluble iron which is essential for this organism[5] was not a limiting factor. An important point in connection with these experiments is that the alkaline limit for the growth of this species as reported by Wann and Hopkins[6] must now be extended to higher pH values since pH 8.0 is very close to the limiting reaction reported by them. Other experiments show that, when manganese is added to manganese-free cultures which have shown no development of the organism in two weeks, growth then begins. The cells with which the cultures were inoculated were not dead but were unable to develop without manganese. I have also found that manganese will not replace iron—both are essential.

In most of the literature on manganese an explanation of its action has not been attempted. The present writer wishes to suggest that manganese functions physiologically in an indirect manner by its action on the state of oxidation of iron. In other words, manganese tends to control the ratio $[Fe^{++}] : [Fe^{+++}]$ in the culture or in the cell. Experiments *in vitro* have shown that the reduction of ferric iron to ferrous which is brought about slowly by sodium citrate tends to be prevented by the presence of manganese. For example, a solution of ferric chloride and sodium citrate on being allowed to stand in a stoppered flask lost its original greenish-yellow color after some time. A similar solution which contained manganese did not change color. On testing them the first one showed only a slight test for ferric iron and a strong test for ferrous iron, and the second solution showed just the reverse.

Culture experiments with yeast also indicate that the reduction of the iron by the yeast organism tends to be prevented by the presence of manganese. Further, oxidation-reduction potential measurements on culture solutions containing ferric iron and sodium citrate show that when manganese is added a higher potential is developed.

On this basis it is believed that not only the necessity of manganese but its toxicity can be explained. In the first case, sufficient manganese must be present to insure the reoxidation of the iron after its reduction by the organism. In the second case, a large amount of the element either results in too high a concentration of ferric ions or prevents its reduction by the organism. Different species may be expected to vary in their relation to manganese depending on the reducing power of their cells.

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[5] E. F. Hopkins and F. B. Wann, "Iron Requirement for Chlorella," *Bot. Gaz.*, 84: 407–427, 1927.

[6] *Bot. Gaz.*, 83: 194–201, 1927.

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ANIMAL PARASITES OF MAN AND THEIR CONTROL[1]

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SOME years ago a party of travelers lost its way on a by-road down South, coming finally to a cross-roads store. Against one corner leaned a lethargic, malaria-ridden cracker, meditating over the chewing of a straw. The driver of the automobile hailed him, "Is that the highway yonder?" "I don't know." "Where does the road go at the fork ahead?" "I don't know." "You don't know much, do you?" "No, I don't know much, but I'm not lost." That is our position to-day with reference to the animal parasites of man. Their tremendous number and fecundity, the mystery of their origin, our lack of specific or any treatment in many cases, our defective knowledge of their natural history, our ineffective methods of control, our feeble prognosis of their future relations to man—these things make us humble in the face of this great broadcast system of parasitism. It is worthy of study for three reasons: because of pure academic interest, because of the clinical and public health need of control, and because in it is written the foundation of human history.

Parasitism is a term coming down from the ancient Greek days of parasites—sharers of the feast, or messmates, to whom no stigma attached, or reproach or contempt. Religious parasites were attached as assistants to the priests to collect the corn dues from farmers on the temple lands or from other sources. It was their province to provide food for temple visitors, to care for certain offerings and to arrange the sacrificial banquets. On the other hand, civil parasites were persons who received invitations to

[1] Presented before the Pasteur Society of Central California, Clift Hotel, San Francisco, September 24, 1930. From the Pacific Institute of Tropical Medicine within the George Williams Hooper Foundation for Medical Research, University of California, San Francisco, California.

dine in the prytaneum as distinguished from those who had the right to dine there *ex officio*. (The prytaneum was the official and religious center of the community.) Much later, the term parasite evolved to mean a person who would submit to any indignity or humiliation in order to obtain a good dinner, in other words, a "sponger." Plautus describes such parasites in his comedies. Alciphron and Athenaeus detail the various insults they endured from hosts and guests alike. Some of these parasites became professional jesters, like the court fools and buffoons of a later age. Some relied on flattery to secure free feasts. Others practiced various degrading vices to achieve their end.

The evolution of the word "parasite" more than suggests the story of the evolution of parasitism as used in biology. In each case the species begins with a free-living form, independent and with diversity and good development of functions. By natural accident, these free-living forms were placed in temporary close relationship with potential hosts. Some few sacrificed independence, locomotion, individual defense and various special senses (moral or physical), in order to secure an abundant food supply and protection. This led to a one-sided development of adaptation or sycophancy, with a stimulation of reproduction and simplification of structure and function. In the end, in each case, we find a parasite incapable of existence aside from its host, and so modified by adaptation to its host that little resemblance remains to its free-living ancestors. Thus we consider as parasites such animal organisms as live upon, within or at the expense of other animal organisms. Parasitism means the relationship obtaining between the parasite and its host.

ORIGIN AND EVOLUTION OF PARASITISM

Chiefly for want of a better thesis, it is commonly assumed that the animal parasites of man originated from free-living forms. For each parasitic form there is a considerable and often very large number of closely related free-living forms. There is no such thing as a group or class of parasites since almost every animal group contains actual or potential parasites. Fantham says that parasitism, biologically, is in no sense a matter of structure, but is very definitely a manner of existence. It is a habit which theoretically may be assumed by almost any living organism.

The usually accepted mode of parasitic evolution assumes that free-living forms of animals are older than parasitic forms, since free-living forms must have been in existence before they could find hosts to parasitize. This is almost a paranoid type of argument because it may well prove to be founded on a false hypothesis. No one ever saw a free-living animal change into a parasitic form. The pure theory of mutation of species has proved a serious stumbling block in general evolution and is just as great an obstacle in the evolution of parasitism. We *know* absolutely nothing as to the real origin of parasitism and processes of change which we observe in fleeting glimpses may be proceeding either forward or backward. It is possible to change the habits of a free-living animal so that it adapts itself to a variable degree to a host in a parasitic relation. It is also possible to take a parasitic form and train or adapt it to a more or less independent free-living form. Which is the archetype? We do not know. We assume and infer, and our *method* is correct because we plant a germ of observation and out of it grows stalk and leaf of hypothesis, and then the blossom of full-grown theory, and a promise eventually of obtaining a modicum of fruitful truth. So that while we must theorize, it must be with the effort to improve the theory with wider and keener observation and experiment, realizing that the final truth is far off and possibly very different from the ideas we entertain en route toward it.

Having assumed that animal parasites originated from free-living archetypes, we are next confronted with the difficulties of the general evolution theory itself. Three major types of general evolution have been advanced and each of these offers interesting and self-evident bearings on the problem of the evolution of animal parasites. First of these is the Darwinian theory of mutation through continuous and long-continued variation. The second theory of DeVries considers species to have arisen through sudden and irregular mutation as environmental circumstances for a time became favorable to such changes. The third theory has recently been propounded by the Dutch botanist, J. P. Lotsy, who believes that new species have arisen by crossing of dissimilar parents. Lotsy insists, in spite of the plausibility of the mutation theories, that it has never been really proved that a new species arose in this manner. The only new forms produced experimentally, have been a result of hybridization. He considers it quite possible that the main divisions of organic life originated from hybridization. A fourth theory from a completely new view-point challenges attention for its novelty, close-knit argument and the unique application to biology of the present-day knowledge of atomic physics. Those interested should read the recent volume entitled "What is Life?" by Dr. Augusta Gaskell, and the thought-provoking introduction by Raymond Pearl. Dr. Gaskell applies the principles of atomic physics to the problem of the origin and

nature of life. It is her contention that species may arise *de novo*. Her argument raises many interesting questions in connection with the development of parasitism.

It is usually believed that external or ecto-parasitism evolved before endo-parasitism, the reason being that the change from free-living to ecto-parasitic existence seems less radical and abrupt than the change to endo-parasitic existence. For instance, some more occasional or partial parasites took their human host solely at mealtime as in the case of the leech (Hirudo) and the bedbug (Cimex). This is more a predatory relation and is much less difficult to establish than the relation necessary for a parasite in the intestine or the blood stream. The parasitic habit seems to have arisen separately and independently in most large groups of animals and therefore might be considered of rather common occurrence in the course of general evolution. This is shown by the presence of free-living as well as parasitic types in most large animal groups.

We must consider that, in general, parasites belong to animal groups more primitive than their hosts, that is, to groups of a less specialized and less highly developed type. In the case of protozoa, the rule still holds because protozoa are parasitized by plant organisms. Some ecto-parasites are not limited to one species of host. Others are so limited and some even to a single part of the host's body. These types are assumed to be evolutionary stages of ecto-parasitism. The most primitive stage is probably where the ecto-parasite is able to migrate from one species of host to another. With more specialization it becomes limited to a single host species, and finally to a single part of that host.

The relation of ecto-parasites to endo-parasites affords much food for speculation. Many believe that symbiosis and commensalism lead to parasitism. For instance, an organism that takes its meals in a state of mutualism with another organism, may easily become a food robber, and then a parasite. Or again, symbiotic relations may be disturbed so that one organism gradually becomes pathogenic for the other. Such a situation would help explain the moot question of pathogenicity of *Entamoeba coli*, for example. In general we assume that endo-parasitism arose (1) from ecto-parasitism, (2) from commensalism, or (3) from symbiosis. An endo-parasite restricted to one species of host is probably no older in race than its host and changes in the parasite have probably been coincident with changes in the host. An endo-parasite found in several species of hosts probably is older racially than these hosts, and has adapted itself to hosts which evolved after its parasitic habit was established.

Faust has introduced the logically correct term "guest," for a parasite in relation to its host. In the case of helminths, he suggests that the relation was first one of chance contact only, whereby a free-living guest was carried from one feeding ground to another. Sooner or later the guest began to use food procured by the host, and gradually became more and more dependent on such food Some of the guests then began to consume the tissues or juices of the host itself, either by use of suctorial organs or by actual penetration of and residence in the host's tissues. This resulted in a very degenerate and dependent parasite. Forms living in the blood or lymph, such as filaria and blood flukes—in the muscles, such as trichina—or in the pleura and peritoneum, such as hydatids—are usually most highly modified or adapted and may therefore be considered the oldest parasitic species. Other forms living in the mouth, bladder and other epitheliated organs, or as ecto-parasites on the skin, are frequently very young in parasitism. This is demonstrated by their relatively slight modification from the archetypes of the group and from related free-living forms. It often happens that the adult parasite undergoes only slight modification, while the larva, or intermediate form, is highly modified.

Greater length or age of parasitism means greater modification away from the archetype of the species. This means practically greater simplification of the parasite. Change of environment from a free-living existence to one of abundant and assured food supply, and increased protection against enemies, leads to atrophy of certain functions and structures. This is not degeneracy, but evolution; not retrogression, but orderly change. Herein, perhaps, lies a warning to the advocate of return to a so-called simple life. The simple life connotes protection and a free-lunch counter. The result is social parasitism.

Faust states that simplification, which is synonymous with adaptation, is illustrated in the helminths by reduction in organs of locomotion, except in free-living larval stages. An even more radical reduction takes place in the organs of alimentation. In tapeworms, for example, the digestive tract has entirely disappeared except for possible vestiges in early larval stages. The integument has been simplified to afford protection against digestion and abrasion by the intestinal contents, and to permit attachment to the intestinal wall by suckers, hooks or by penetration. On the other hand, the reproductive system has increased enormously and this makes a serious

public health problem. The nervous and excretory systems have suffered little change. There is a striking contrast between the influence of an easy life on reproductivity in parasites and most of the animal kingdom, and in man. In man it is as Adam Smith said, "Poverty seems favorable to generation. But poverty, though it does not prevent generation, is extremely unfavorable to the rearing of children."

As we approach the problem of the host in relation to the parasite, it seems probable that parasites using intermediate hosts have evolved from parasites having but one host. At first, the parasite would have merely tolerated the second host, then would have adapted itself to the second host, and finally established itself in some stage in the second host. Nature provides numerous examples of the entrance of exogenous stages of parasites into other animals and therefore abundant opportunity exists for parasitism to develop and for intermediate hosts to enter the cycle. Adaptations often of unusual nature are necessary to permit the parasite in its larval or oval form to reach the intermediate host. This is nicely portrayed in the life cycle of the guinea worm, of flukes and of hookworm.

The problem of intermediate hosts is far from settled. R. Leuckardt believed that the present intermediate hosts were the original or primitive hosts both for larval and adult forms. Parasites then gradually differentiated and developed into later and more numerous stages, which in turn gradually sought out new definitive hosts. The earlier stages remained in the original hosts, now called intermediate hosts. This theory at once meets with objections.

On the contrary, R. Moniez considers the present definitive hosts to have been the original ones, and that ascaris, trichinella and enterobius, for instance, have continued this primitive relationship. In most other cases embryos, which were potential parasites, were unable to resist or endure the chemical and mechanical influences of the intestinal tube. They therefore left the intestine by penetrating its walls and burrowing through into the tissues of their carriers or the primitive hosts. Here they could attain a fair degree of development, but were mechanically prevented from returning to the intestine where their eggs could be deposited. Most of them died out as parasites, just as their young stages do now if they reach a wrong host. Nevertheless some of them passively were carried into the intestinal tract of beasts of prey. Many perished in the process of digestion, but a few reached the intestine undamaged. These grew, became more resistant and developed into adult forms. Gradually this process became established by heredity, and became usual and normal. This is an attractive theory and has in it much to commend.

Under unusual or special conditions parasites may invade unusual hosts. They then tend to aberrant locations and are often very dangerous, as shown by *Cysticercus cellulosae*, for instance. A common example is also seen in the so-called larva migrans, or creeping eruption, due to larvae of non-human nematodes, such as the dog hookworm, penetrating human skin and crawling about in the subcutaneous tissue. It is possible that *Loa loa* may represent a similar condition.

In general, true or strict parasites have specific hosts. The great exception to this rule is *Trichina*, which is found in man, pig, bear, rat, mouse, cat, fox, badger, skunk and marten, and can be artificially cultivated in the dog, rabbit, sheep, horse, other mammals and in birds. Intestinal and ecto-parasites are usually less dangerous than blood and tissue parasites. The origin of host-parasite specificity is the same as the evolution of parasitism.

Faust emphasizes that, as a host, man, like other animals, suffers more from parasites if they are relatively new to him. Long acquaintance brings tolerance, here as everywhere. In fact, we might well paraphrase the insight of Pope's famous lines in his "Essay on Man," and say:

> Parasites are monsters of so frightful mien,
> As to be hated, need but to be seen;
> Yet seen too oft, familiar with their face,
> We first endure, then pity, then embrace.

Negroes are less disturbed than whites by intestinal worms. Chinese are commonly little affected by clonorchis. The Asiatic child is less upset by ascaris. Perfect adaptation of parasite to host means a complete absence of symptoms. This principle is seen clinically illustrated in the case of infection with *Entamoeba histolytica*. If the parasite is poorly or badly adapted, symptoms arise. Millenniums of association in the host-parasite relation definitely seem to decrease pathogenicity. This gradual racial immunity has many counterparts in clinical parasitology. Even California fleas prefer the fresh blood of newcomers. We have no answer, as yet, to the question as to why insects exercise a selectivity at times in the individuals they select as donors for transfusion. Yet such selectivity exists at least in the case of fleas, bedbugs, mosquitoes and sandflies.

Enough has been said to indicate the extreme complexity of the world of animal parasites. With so little definite information on the subject of the origin and evolution of parasites, we are forced to base practical measures of control on studies of para-

sitism as it exists to-day. Certain features of parasitism are of special interest, therefore, when we come to consider the principles on which specific control may be based.

Host-Parasite Relation

Granting a condition of parasitism, the optimum habitat for the parasite is provided when there is the least possible or no damage to the host. The host-parasite relation must be considered as a finely adjusted balance of biology, in which the parasite must preserve itself and perpetuate its race, and in which the host must not be sufficiently irritated or damaged to react in such a way as to prevent achievement of these two objects by the parasite. This is illustrated with nicety in the case of *E. histolytica* in relation to its host.

For infection of the host, it is necessary that host and parasite have the same geographic distribution, the habits of the host must bring it in relation with the infective stage of the parasite, and the infective stage in the life cycle of the parasite must be reached at the precise time the host is available to be parasitized. Numerous remarkable adaptations occur as a result of the need of meeting these requirements. Some of these can be indicated as follows:

1. Guinea worm—Cyclops—ingested by man.
2. *Leishmania* and *Loa* in skin (Sandfly and *Chrysops*).
3. Leeches (*Hirudinei*). *Limnatis nilotica* in drinking water, lodges in nose and pharynx. (See Alfred Russell Wallace and Loos, *Haemadipsa* species.)
4. *E. histolytica*—cysts to exterior—to new host.
5. Hookworm—intermediate cycle.

It has been mentioned that parasitology has a contribution to make to the prehistoric record of man. This is illustrated by a type of reasoning first developed by von Jhering in 1902.[2] In the case of parasitic worms von Jhering argues that if the same or nearly the same species of worm parasitizes two or more species of hosts, then the hosts descend from a common ancestor. The similarity of the helminth parasites indicates their origin also from a common ancestor. Thus, apparently, the different species of hosts involved all descended from a primitive ancestor which was parasitized by the original ancestral parasite.

Zschokke has applied a similar argument to the distribution of certain cestodes in marsupials. He also claims that the original home of the salmon is in the salt ocean because the larger proportion of its endoparasites are marine. Thus the path of salmon migration and its breeding grounds are no index as to whence it came. Zschokke says, "Each parasite fauna comes to be to some extent a mirror-image of the biology of the host, of the host's habits of life, and especially of the host's relations to those creatures that share the habitat with it. Each change of nourishment and residence of an animal finds its echo in the changes in the helminthic condition."

Metcalf has discussed the distribution of the family *Leptodactylidae*. These are frogs characteristic of tropical and sub-tropical America, and also of Australia and Tasmania. They have been reported from no other parts of the world. Only two explanations of this distribution are possible. (1) Assumption of an earlier land bridge across Antarctica, connecting South America with the Tasmanian-Australian plateau. (2) Convergent or parallel evolution. This frog family harbors an opalinid rectal parasite of the genus *Zelleriella* which is present in both geographic groups of frogs. So nearly alike are these opalinids that their species separation is most difficult. It is possible that either the frogs or the opalinids arose by parallel or convergent evolution. But it seems utterly impossible that *both* frogs and opalinids developed such a similarity in the two geographic areas. Therefore we must assume a primeval land bridge.

Kellogg has applied this reasoning to bird lice, Johnston to trematodes and cestodes. Darling studied the migrations of the human race from data on hookworm distribution. The method is valid and opens the way for much valuable new work on human geography and evolution. This is especially hopeful because parasites include the latest known examples of biologic evolution (Metchnikoff).

The principles of parasite control are to-day too specialized, varied, empirical and ineffective because of insufficient data in certain definite lines. These are chiefly: (1) Data on evolutionary development and individual life stages as influenced by external factors. (2) Distribution of parasites and extent to which they can and do enter other hosts than the principal one. (3) The extent to which behavior of parasite and of host influences or determines specific relations between the two (Hegner). (4) The factors in the host which favor invasion and establishment of so-called natural parasites and obstruct similar entry and establishment of foreign parasites (Hegner). (5) Reasons for laboratory, experimental and accidental infections in foreign hosts (Hegner). (6) Understanding of immunity and susceptibility in hosts, racially, from heredity, difference between individual hosts of same species, and between young and adult hosts. (7) The reactions between host and parasite which terminate an infection or cause latency

[2] See Hegner, Root and Augustine.

or relapse. Better data on these points will greatly improve methods of control.

The extremely small number of infective forms which reach a new host necessitate an enormous fecundity in parasites. Transfer to new hosts may be purely passive, by contaminated food or drink, by direct contagion, by inoculation, or may be pre-natal. *Therefore simple sanitary measures are usually sufficient to prevent individual infection.*

Before taking up the specific problem of parasite control it will round out the entire subject to review, briefly, current ideas on the antiquity of animal parasites, especially helminths, in man. Faust states that parasitism was well established before the dawn of human history. All the common species of human parasites are much older than the genus man. This statement is based on the following considerations: (1) Many infections of man are also common in animals, and man is only incidentally or accidentally infected. (2) Some infections are decidedly pathogenic for man but not for other animals. (3) Many parasites which now use two or more hosts, including man, probably originally used only one host, the one in which their larval stages now appear. (4) Certain groups of parasites of man and other mammals have a similar or identical morphology but widely different physiologic processes. This indicates that the parasite has been established in man long enough to have acquired a relatively fixed adaptation. (5) Strongylus, for example, is a fairly recent parasite of man because its free-living stages, which are reproductive, can probably continue indefinitely outside the human host. Hookworm has a much longer parasitic history, while ascaris, trichocephalus and enterobius are extremely old in parasitism and their entire life history is carried on in man. Parasites of the blood and lymph are the oldest of all and have undergone much more profound adaptations, especially in physiology.

The ancient story of parasitism is nicely summarized by Faust. Long before the dawn of history, at least 100,000 years ago, hunters of wild oxen and boars became infected with tapeworms, ascaris and trichina. Primitive fishermen, eating raw fish, acquired *Diphyllo bothrium* and the liver fluke. Herdsmen were infected with hydatids from sheep and dogs. Guinea worm infection and filaria have a similar antiquity. As man settled down and began to till the soil, he came in closer contact with his own race and bad hygiene exposed him to fecal contamination. Hookworm, strongylus, ascaris and tricocephalus became endemic. In the great valleys of the Nile and Yangtze, fishermen and farmers wading in stagnant water were infected with schistosomes. Man's associate, the rat, conveyed hymenolepis, and became a reservoir for trichina, while the dog flea conveyed dipylidium. Thus at the dawn of history, helminth infection at least was distributed through the inhabited world, but more intensely through the tropics.

Vesical schistosomes have been found in Egyptian mummies of the 13th century B. C. Moses separated clean from unclean animals on the basis of their visible infection with parasites. This was especially so in the case of goats and kids offered for sacrifice and later eaten. Syrian goats are heavily infected with *Fasciola hepatica* and persons eating infected raw livers get a disease called "halzoon," or pharyngeal fascioliasis. All scavenger birds and beasts were prohibited as food, including hogs, camels, birds of prey, reptiles, snails and others. They were prohibited because their flesh was infected with parasites. All animals not on the prohibited list, whose flesh was found infected, were to be burned. Moses warned against infected water, containing cyclops and cercariae. He taught the people by his brazen images of the fiery serpents how to extract the guinea worm. Later the people were instructed to drink water from their hands instead of lapping it up, possibly to avoid leeches. Many references record the acquaintance of the ancients with animal parasites.

CONTROL OF ANIMAL PARASITES

Nearly every group of fauna has in it parasitic species. From the social point of view, this is also eminently true for man himself and brings up the whole field of social human parasitism which has been very insufficiently studied from the biologic point of view and from the standpoint of human geography. In the phyla of the animal kingdom, some have only a few parasitic forms, but three phyla contain a large number, in fact, a majority of animal parasites. These are the protozoa, arthropoda and several phyla of worms.

The general principles on which control must be based have already been discussed. It remains to consider broadly the large parasite groups, commenting on control methods in relation to each. We deal with Worms, Protozoa and Arthropods.

I. WORMS: The spread of helminths requires the presence of proper intermediate hosts, of suitable climate and moisture, available definitive hosts, and proper interrelations between these and the general environment.

The spread of helminths is determined largely by certain factors which are more or less subject to human control and which therefore offer the practical points of attack on the problem.

1. *Food:* Faust gives many examples of the importance of the type of local native food. Thus the Chinese and Hindus thoroughly cook most of their food, which is largely eaten hot. (Note also the importance of the tea habit.) However, in China and India some cooked food stands in stalls and restaurants, covered with flies and dust, and exposed to domestic animals, roaches and vermin. To all this the people are oblivious, since they completely lack a sanitary sense. We see analogous food exposure in nearly all countries: in Italy and France, the bread; in England, the milk; in the United States, berries, vegetables, fruits and salads are often exposed to flies, dust, expectoration, dogs, cats, rats and mice, etc. In the orient and most of the tropics, all foods raised in the ground are invariably contaminated. Many are kept fresh in the bazaars by sprinkling with dirty water applied by whisks or blown by the mouth. In China, water chestnuts, the gigantic Chinese radishes, lotus roots and bamboo shoots are eaten raw. From Egypt to Iraq sticky sweetmeats, drowned in flies and dust, are consumed by rich and poor alike. Sugar-cane sections are kept fresh in dirty water. China gives a hypo of dirty water to oranges beginning to wither, just as she soaks melons and cucumbers in dirty water after tapping their skins with stiff bristle brushes, and then sells them honestly by weight. Fresh berries, celery, lettuce and other salad plants are anathema in the tropics, yet the plain laws of common-sense and sanitary sense are ignored by native and foreigner alike.

Chinese and Indians eat the water ling and chestnut by peeling off the outer petals with their teeth, and become infected with the cysts of *Fasciolopsis buski*. In China and Formosa, the same result follows eating certain raw grasses. It is common knowledge among the farmers of central China, where *Fasciolopsis* is abundant, that hogs raised in the courtyard escape it, while those raised on the hillside get it. Yet the farmers do nothing whatever about it. The situation reminds one of our own ignoring of well-known sanitary facts in sewage disposal on the farm, as well as in garbage disposal in the city.

In general the Chinese do not eat raw fish and arthropods as do their neighbors around the China Sea, but in some parts they eat large quantities of dried fish. Raw fish and arthropods spread flukes, especially metagonimus, clonorchis and paragonimus, broadcast in Japan, Formosa, Korea and Tonkin. In the wetter parts of China, clonorchis and metagonimus are found in cats and dogs. Several central provinces of China, especially Fukien, Kiangsi and Hunan, have paragonimus infection in tigers, panthers and wild cats, just as in Korea, Siam and Assam. Attention must be drawn also, in connection with food as a spreader of parasites, to the importance of the dirty fingers or utensils with which the food is eaten. The chopsticks of eastern Asia are more sanitary than the vilely contaminated fingers of Mongolia, the Near East and Arabic countries.

2. *Water,* as a means of transfer of helminths, is never safe in the orient or tropics, and often unsafe elsewhere. Examples of water transfer are seen in the cercariae of various flukes and the larvae of the guinea worm.

3. *Nightsoil* is perhaps the chief potential source of human helminth infections. In the orient and tropics nightsoil is universally used as a fertilizer for the fields. The sights and smells of this traffic beset the landscape and offend the senses in city and country alike. By this means virulent bacteria and numerous parasites are propagated and broadcast over the land. Not only are the farmers and coolies subject to infection, but field produce, vegetables, fruits and melons, are all grossly contaminated and carry contagion to those who eat and drink without thought for the morrow. The use of nightsoil as fertilizer is a logical and economical system. In the West the form of fixed nitrogen most valuable for plant use is entirely wasted by our wasteful and short-sighted conservancy methods. The Chinese method is effective, saving, logical, but unesthetic and disease-breeding. Parasite control must go hand in hand with good economics and a reasonable degree of esthetics.

4. *Migration and Travel:* Negro slaves from Mozambique and the Gold Coast probably brought hookworm and Manson's schistosome to America. The former needed no adaptation and the latter found *Planorbis* snails awaiting it as intermediate hosts. The fish-tapeworm was carried to Switzerland a thousand years ago by Swedish emigrants and to the United States and Canada by Scandinavian emigration. Wherever Islam spreads, *Taenia solium* disappears and *Taenia saginata* becomes endemic. Travel and migration are of great importance in spreading all parasites. Conversely, parasites are important in diverting or causing emigration. In the seventh century the Moslem invasion of North Africa did not cross the Sahara because all livestock was inoculated with trypanosomes by the tsetse fly at the southern borders of the desert.

5. *Influence of racial and local habits,* food customs, manner of eating, bathing, clothing, housing, conservancy, occupation and religion. These things all have an important bearing on helminth spread and practical means of control.

6. Spread of helminths depends to a considerable

degree on the presence of vectors and proper intermediate hosts. Plants may act as vectors as where they harbor encysted fluke larvae, and where heavy fleshy roots are parasitized by plant nematodes and then eaten by man. Invertebrate intermediate hosts belong to the two large phyla of molluscs and arthropods. Vertebrate intermediate hosts include fish, reptiles, amphibians and occasionally birds and mammals.

The public health aspect of parasite control is highly important. Carriers, either as intermediate hosts or as simple vectors, with or without symptoms, must be prevented from introducing parasites to new hosts. Studies of reservoir hosts need to be pushed. Human parasites in animals are important and little is known about them. A helminth can easily become epidemic in an area because of massive dosage or unusually favoring climatic conditions. Generally helminth infection is endemic and when once established with intermediate hosts, if needed, constitutes a vicious circle extremely difficult to break. One must search for the weakest point locally in the life cycle, with considerable knowledge of the evolution and biology of the parasite, in order to decide the most amenable point of application for preventive measures. In all parasitology, prevention is vastly more important than an attempt at control by cure. Human exposure can be minimized by public education in methods of spread and manner of entry into the body, as has been done in the case of hookworm disease. Wholesale treatment of patients has its function (1) in the clinical needs of the patients themselves, and (2) more vital from the public-health view-point, in protection of intermediate hosts and vectors from infection, and in preserving water and earth from infection. Control measures therefore may be directed to the intermediate hosts as in the schistosome problem of Egypt; to protection of the intermediate host from infection, as in the prophylactic use of quinine against malaria; to protection of man from entry of the parasite, as in the case of guinea worm and numerous other parasites; to cure of the infection in man; to improved personal hygiene, sanitation and conservancy.

I. HELMINTH PARASITES: This field is fairly familiar to medical workers and can be summarized briefly. Of the parasitic worms, we deal chiefly with the following groups: trematodes; cestodes, including hydatid; round worms, subdivided into the hookworm group including strongylus, ascaris and enterobius, and the filariae. The principles already reviewed are applied to each of these in its local setting with reference to environment both physical, biologic and social. In the case of filaria, we have to admit little progress and less knowledge. This widespread and dangerous group of worms has so far been refractory to control because of unknown factors of evolutionary development, life history, biology and psychology. The need and opportunity for new experimental work here is obvious.

II. PROTOZOA: Turning now to the second great parasitic group, the protozoa, we find practically every point applicable which was mentioned under the general control of parasites. These need not be repeated. The groups of protozoal parasites most important to man are as follows:

1. *Malaria:* Here it must not be forgotten that it is perhaps more important to protect the mosquito than man against malaria. If human disease is controlled there will be no transmission. If certain species of anophelines alone are controlled, others will take up their duties.

2. *Leishmania:* Here we have theoretically two methods of control, by eradication of sand-flies and by cure of patients. The former can not be done. The latter is effective on a wholesale scale.

3. *Coccidiosis:* Coccidial infection is so rare that little can be said as to its control. Probably, however, it is a late example of parasitism which longer adaptation may spread more widely and make more serious. It therefore needs detailed study to allow exact control to be instituted before it becomes a serious human parasite.

4. *Trypanosomiasis:* Space forbids even mention of the exceedingly interesting work being done in Africa on the control of trypanosomiasis. Various governmental institutes and numerous private organizations and individuals are involved and the outlook finally is hopeful. For American trypanosomiasis, or Chagas disease, not so much can be said.

5. *Rabies* is world-wide in its distribution and is rampant in the orient and all tropical countries, largely because of religious *beliefs* or indifference, which allow a large predatory and scavenging dog population. Similar factors are operative in the United States. For human purposes, control lies in dog control. This is to-day an impossibility in most countries, especially in hot latitudes. Even in the United States we are afflicted with that superparasite, highly adapted and late in evolution, the sob-sister of science, Sentimentalism. Her disguises cover Eddyites, anti-vivisectionists, maudlin animal lovers and a host of misguided ignoramuses. The total effect of all these differs only in degree from the effect of Buddhist, Hindu and animistic beliefs, so far as disease control is concerned. At present the problem of the dog population, like many another sanitary problem, is insuperable in most parts of the world. Nevertheless, Pasteur Institutes are found in every

chief city and treatments are given in wholesale numbers.

6. *Intestinal Protozoa of Man:* The principles of control have been covered under helminth control and do not need repetition.

III. ARTHROPODS AND ECTO-PARASITES: In this third heterogeneous group of animal parasites are included many familiar pests and strange histories. To some extent the principles of control we have reviewed come into account, but there is much more departure from rule in this group and greater diversity and originality in the parasite's relations to the human host. A brief note, following Ewing's text, on some of these ecto-parasites is all that time will allow.

1. *Mites* (*Acarina*): Of these there are enormous numbers of very small animals. Several million individuals may occupy a few cubic inches. They are found from northern Greenland to the Antarctic. Each group has been derived apparently from a different type of free-living ancestor. The common habit of parasitism has brought frequently similar adaptations of structure and physiology which give different racial groups a close superficial resemblance. They attack land and aquatic hosts, both vertebrate and invertebrate. Every small rodent is apt to harbor several species. Because of their range and intensity of parasitism, it is believed that parasitic species far outnumber free-living forms. In species they may even outnumber the insects. Some mites are very old in parasitism and the morphologic adaptations are profound. Such differences mark off, for example, the itch mites and the ticks.

The reasons for such frequent parasitism in the mites are to be found in their minute size, enormous abundance, wide distribution and great variety of habits in the free-living forms. Nascent parasitism is seen now in certain living forms as in *Pediculoides*, where a single species may be either a predator, a parasite or a scavenger. It may be one or all three with equal facility depending on the hazards of environment.

2. *The Ticks* (*Ixodidae*): These are a small group, numbering less than 300 species altogether. In number of individuals this is one of the largest and most important groups of all ecto-parasites. They originated from mites and even now the two groups show many structural similarities. *Spelaeorhyncus praecursor* on bats is an excellent example of an intergrade between mites and ticks and may be classified with either. They are important disease carriers, as of spotted fever, and protection against them even yet is chiefly mechanical.

3. *Biting Lice* (*Mallophaga*): These spend their entire life on the host, laying eggs on feathers or hair. They feed chiefly on the barbules of feathers, on epidermal scales and oily secretions of the skin, but at times blood is found in them. They are closely related to the sucking lice. They are characteristic on Australian marsupials, are common on nearly all birds, and are conspicuously absent from several large mammalian groups. The most ancient group of land birds (Galliformes) have the most generalized types of lice which are almost identical with those of the Australian marsupials. The marsupials probably were infected from birds, just as the domestic dog of North America got one louse (*Heterodoxus longitarsus*) from Australian marsupials.

4. *Sucking Lice* (*Anoplura*): This is one of the smallest insect orders with less than 200 species, and is confined to mammals. One family (*Haemato mysidae*) has one species only, and this is found only on elephants. Marsupials, bats and a few other groups have no sucking lice. Blood is almost the exclusive diet of the *Anoplura*. They are therefore important disease carriers, especially in relapsing fever, the typhus fevers and trench fever. Their origin is an unsolved mystery. Their mouth parts resemble those of the true bugs (*Hemiptera*). Their control lies in individual treatment primarily, with disinfection of clothing, personal cleanliness and good housing.

5. *Fleas* (*Siphonaptera*): Fleas are of perennial and especially autumnal interest in California. They are small, laterally compressed insects which are not closely related to any other order. They resemble biting lice in being found on birds and mammals. They are so highly specialized that they can not be traced back to their origin. They constitute an order of remarkable unity and can be divided into families with only partial success. The ordinary human flea is common in Europe, in parts of the Mississippi Valley and especially in California. Their life history is full of interest and their relation to plague transmission is a specialty in itself. While most genera have a favorite host they do not hesitate to bite another host. The rat flea (*Ceratophilus*) dislikes to bite men and the mouse flea does not bite man. *Ctenocephalus* of dogs and cats is not a plague carrier as it rarely bites rodents. The biologic situation in connection with plague is exceedingly complex and far from perfectly understood.

A small group of highly specialized and abnormal fleas is named chigger, jigger, chigoe or sand flea. Those which invade man are called *Tunga penetrans* or *Dermatophilus*. The female burrows under the skin, forms a cyst and lays a huge mass of eggs. Local irritation and secondary bacterial infection are

often serious. It originated in South America but has been carried widely around the world. It attacks many animals, but especially, like *Pulex irritans,* in addition to man it loves the pig. Many biting insects for some strange reason associate man and the pig as hosts, possibly, however, because both have hairless bodies.

Flea control again leaves us dependent primarily on personal cleanliness of living quarters of dogs and cats, with the use of mechanical protection, including more or less effective insecticides. Flea eggs are laid on floors, in nests, dust and refuse and here they pupate. Sanitary cleanliness goes far to reducing the mass attack on man. Here, as in the case of many other animal parasites, there is need of investigation for sub-parasites to destroy the parasites. Excellent work has been done in adapting certain parasitic hymenoptera to this function and the subject is full of promise.

6. *Myiasis* is a condition in which certain fly eggs are laid in wounds or natural cavities of the body, leading to tissue invasion by the maggots and a frightfully severe course clinically. Protection against flies of these types is always important, and local treatment and removal must never be delayed.

CONCLUSION

We have reviewed in summary fashion the general field of the animal parasites of man, emphasizing the factors of origin and evolution on which adequate control must be based. We have seen how fragmentary is our knowledge and therefore how difficult effective control is under present conditions. Parasitism deserves a much more prominent place in general biology and in medical education. Research fields in urgent need of cultivation are along the following lines: (1) Study of natural enemies of parasites. (2) Economic methods of control of sanitary food supply and water provision. (3) Methods of protection of potential intermediate hosts and vectors, as well as soil and water, against infection. (4) Methods of public health control based on epidemiology and biology. (5) Development of new specific remedies. (6) Better conservancy methods in rural, tropical and oriental districts. (7) Popular education, not in parasitology, but in health preservation by avoidance of specific hazards.

Our review has been in general terms. No field, however, offers greater fascination and promise for the student and the research worker. The sociologist and economist also might well devote serious study to parasite and disease control in the world as a whole, because the irrepressible tide of nationalism all over the world is rejecting foreign ideals and ideas along with foreign domination. And in the tropical and oriental countries which contain most of the world's population, a sanitary sense is distinctly a foreign ideal.

NOTE: The texts of Hegner, Faust and Ewing have been drawn on freely in order to build up a general picture of animal parasitism. The purpose has not been to present original work or ideas but to furnish a survey of the field, and to orient the student and technician. For this reason, annotations have been largely eliminated and the authors noted, as well as others mentioned in the text, have been quoted extensively. See Hegner and Andrews, "Problems and Methods of Research in Protozoology"; Hegner, Root and Augustine, "Animal Parasitology"; Ewing, "Manual of External Parasites"; Faust, "Human Helminthology"; Reed, "Tropical Diseases in the United States."

OBITUARY

GEORGE McLANE WOOD

GEORGE McLANE WOOD, formerly editor of the United States Geological Survey, died in Washington October 26, in his eighty-first year. Mr. Wood was born in Cumberland, Maryland, but spent most of his long and useful life in Washington. He was the son of Colonel William P. Wood, who was superintendent of the Old Capitol Prison during the Civil War and organizer of the United States Secret Service. One of his brothers was the late Samuel A. Wood, for many years the well-known shipping reporter on the New York *Sun*. Mr. Wood had a public school education, but beyond that the knowledge that served him so well was self-acquired. He was an eager student to the end of his life, delving into many subjects that appealed to him—geology in all its branches, languages, philosophy, botany, and particularly the art of expression in clear, terse, forceful English. Beginning at about his eighteenth year, he did stenographic work for private concerns and the government and was regarded as one of the best and most accurate shorthand writers in the city. For a few years he was secretary to the Chesapeake and Potomac Telephone Company. His life work, however, was done in the United States Geological Survey, of which he was a member for nearly forty years.

In his stenographic work he had already developed

a facility for smoothing out crude English, and this was discovered more or less accidentally by Professor Thomas C. Chamberlin, for whom he was writing manuscript from dictation. Mr. Chamberlin, having had a sample of the help he could give, called for more and spread the word among his colleagues. This probably gave the eventual turn to Mr. Wood's career, for it led to his appointment in the Geological Survey. He served as editorial clerk, assistant editor, and finally editor, the position he held from 1908 till his retirement in 1925. During this long period he taught the scientific writers whose work he criticized to welcome rather than resent his criticism, for they learned that it was neither pedantic nor arbitrary but was based on common sense and an earnest desire to be helpful.

The reports of the United States Geological Survey have a wide reputation for lucid, virile, straightforward expression, which is due in large part to the sincere and painstaking efforts of Mr. Wood. His greatest influence was probably exerted by the modest pamphlet in which he put his counsels into print—"Suggestions to authors of papers submitted for publication by the United States Geological Survey." This pamphlet was first published in 1909 and was revised and enlarged in 1913 and again in 1916. It was of course prepared primarily for authors of geologic reports, but its usefulness in other fields was soon demonstrated. Its 50 pages of "suggestions as to expression" have been found to apply so well to scientific and technical writing in general—indeed, to writing of any kind—that the demand for this pamphlet has been wide-spread and continuous, and instead of its long title it is generally known as "Suggestions to authors." The edition of 1916 has been reprinted seven times—the latest printing in July, 1930—and has been sent on request to government and state departments and bureaus, universities and colleges, research and engineering institutions, business executives, and countless individuals engaged in writing. It has also been highly commended by such eminent critics as Brander Matthews in America and Sir Clifford Allbutt in England.

It had been Mr. Wood's hope, after his retirement from the government service, to expand the "Suggestions" into a more comprehensive manual on technical writing. Such a project had been urged upon him by Director George Otis Smith, of the Geological Survey, and many others, and he saw clearly the widened usefulness that would be given to his condensed advice by more detailed elucidation. He had accumulated some material for this purpose, but when it became known that his services were still available he received so many requests for help that they left him no time for his own work. He was at the beck and call of any one who needed him and, though more than 75 years old, put in longer hours than he had in his official life. The larger part of this work was done in geology and allied fields. His last work for the Geological Survey was done on Henry Fairfield Osborn's monograph on the titanotheres, and Professor Osborn made arrangements for him to continue that work for the American Museum of Natural History after his retirement from government service. He prepared many of the articles on the geology of North and South America in the new edition of the Encyclopaedia Britannica. The recently published symposium "Creation by evolution" owes in no small degree the clarity and force of its articles to his skillful editing, though he preferred to remain anonymous on that work. At the time of his death he was editorial reader for the *Bulletin* of the Geological Society of America and the Arkansas Geological Survey, and one of his latest tasks was to edit a memoir on the geology of Cape Cod for the Harvard Museum of Comparative Zoology. He died practically "in harness," having been ill only three days.

No one could have been in intimate daily contact with George McLane Wood during the last twenty years of his service for the United States Geological Survey without learning to appreciate the spirit that animated him. It was a privilege to work under him, and I am honored in being permitted to pay this tribute to his memory. He scorned hypocrisy and bluff but could not do too much for any one who was earnestly endeavoring to increase the sum of human knowledge. His kindliness was a subject of common remark—he was as considerate of the humble messenger boy as of his chief. His sense of humor was keen and enabled him to take the bumps of life with a twinkle in his eye. His characteristics were well summed up by Professor Harlow Shapley, of Harvard University, who said at the funeral service that he exemplified the four things that justify the experiment of living—sincerity, enthusiasm, skill and usefulness.

BERNARD H. LANE
UNITED STATES GEOLOGICAL SURVEY

MEMORIALS

THE college of forestry of Syracuse University recently unveiled a portrait of the late Dean Franklin Moon in the faculty room of the college. Dean Moon had been connected with the College of Forestry since its beginning in 1912.

As a memorial to Francis P. Leavenworth (1858–1928), professor of astronomy at the University of Minnesota from 1897 to 1927, the University of Min-

nesota Press is publishing his "Measures of Double Stars," left at the time of his death. The book includes a number of measurements made by William O. Beal, who was assistant professor of astronomy at the University of Minnesota from 1913 until his death in February, 1930. The records in the book were made during a period of forty years, and consist of the measures of 1,185 stars. Both Mr. Leavenworth and Mr. Beal were members of Sigma Xi and of the American Astronomical Society.

At the same time that Admiral Richard E. Byrd received the Langley Memorial Medal, America's highest award for achievement in the field of aeronautics, a similar honor was conferred posthumously on Charles Matthews Manly in recognition of his pioneering work in connection with the first aeroplane flight in this country. Charles W. Manly, a Cornell undergraduate, accepted this award on behalf of his father. The exercises took place at the Smithsonian Institution in Washington during the annual meeting of the Board of Regents on December 11. Chief Justice Charles E. Hughes made the presentation address. The Langley Medal has been awarded only five times previously—to the Wright brothers, Eiffel, Curtiss and Lindbergh. The medal is cut from a die kept in the French mint in Paris. The belated honor to Charles M. Manly comes as a result of the suggestion of Mr. Charles L. Lawrance, president of the Wright Aeronautical Corporation. On his graduation from Cornell in 1898, Charles Matthews Manly went to Washington as chief assistant to Samuel P. Langley and was engaged in aviation development at the Smithsonian Institution until 1905. He built and piloted the historic Langley aeroplane in its tests in 1903, when the work was stopped by lack of funds from congressional appropriations.

RECENT DEATHS

Dr. M. A. Miner, until his retirement in 1916 professor of chemistry and pharmacology in Northwestern University, died on December 11 at the age of eighty-one years.

Professor Albert Dickens, head of the department of horticulture of the Kansas State College at Manhattan since 1902, died on November 28 at the age of sixty-two years.

The following deaths are reported in *Nature:* Dr. J. W. Evans, C.B.E., F.R.S., a past president of the Geological Society, on November 16, aged seventy-three years; Dr. E. R. Frazer, a distinguished pathologist and benefactor of the University of Oxford, on November 17, aged sixty-three years; Dr. G. H. K. Macalister, formerly principal of the Singapore Medical College and editor of the *Malaya Medical Journal,* on November 2, aged fifty-one years; Dame Mary Scharlieb, a pioneer in medical education for women, on November 21, aged eighty-five years; Professor J. H. Teacher, St. Mungo (Notman) professor of pathology at Glasgow University, on November 21, aged sixty-one years.

Sir Francis Ogilvie, former director of the National Science Museum at South Kensington, died in Edinburgh on December 14 at the age of seventy-two years.

SCIENTIFIC EVENTS

ARCHEOLOGICAL FIELD WORK OF THE UNIVERSITY OF MINNESOTA IN 1930

Dr. Albert Ernest Jenks, professor of anthropology, University of Minnesota, has returned to Minneapolis after an absence of eight months in archeological field work in North Africa and Europe. Accompanied by Mrs. Jenks and two graduate students, Lloyd A. Wilford and Ralph Brown, Dr. Jenks, in cooperation with Logan Museum, dug shell-heap culture during the three spring months on the high plateau of central Africa.

The Minnesota party spent June in reconnaissance farther south in the barren deserts of Algeria and Tunisia. It located eleven unrecorded shell-heaps, found habitation grottoes and rock shelters in two areas never studied, and in its excavations had particularly good fortune. About 6,000 pieces of flint from the one shell-heap trenched were brought back, while an equal number were left with the Algerian government. The party also found seven human burials in undisturbed position which are of the age of the shell-heap at its mid-development. This skeletal material becomes particularly valuable in America, since the University of Minnesota purchased from M. Arthur Debruge, of Constantine, the type-skull of the shell-heap culture of North Africa, the "Mechta el Arbi" man, found by Debruge in 1912 and first measured and published in 1923–1924 by M. Henri Logotala.

Though the prehistoric stone culture of North Africa was named "Capsian" from the Latin name of the present Tunisian oasis of Gafsa, and again named "Getulian" (a pre-Roman local tribal designation), yet the vast amount of the artifacts assembled for the scientific study of that culture came from the provenence around about Redeyef—a desert phos-

phate mining camp some forty air-line miles west of Gafsa. That area lies in the once well-watered triangle of some twenty-five kilometers along its base on the Southern border fixed by the three barren mountains, Bliji, Chouabine and Alima, with Redeyef close to that base line near its middle. Professor Jenks was fortunately able to purchase the collection of M. Louis Gaillot, of Redeyef, gathered over a period of twenty-five years, which played an important part in M. Gobert's studies of that North African culture ranging well throughout the time and type of the Aurignacian stage of culture in Europe. That collection, together with the entire Debruge collection of artifacts, of animal bones, and of seven human crania—including the Mechta el Arbi type-skull, and the abundant materials resulting from Minnesota digging and surface find far afield in 1930—enable the University of Minnesota to contribute an important part to the ever-growing source-material of prehistory available for students in America.

July and August were spent digging in France and Czecho-Slovakia. In France, Professor Jenks was with Dr. Henri Martin at his famous Mousterian site at La Quina and there dug and from there brought back an extensive and excellent collection of flint and bone implements and more than 100 pieces of animal bone which show the marks of the flint tools of Neanderthal man. The time spent in Czecho-Slovakia was largely in the nature of a reconnaissance, but fruitful digging was done as arranged by the Zemska Museum of Brno. In the vicinity of Znojmo, Neolithic-age, Bronze-age and Hallstad-iron age sites were dug and small amounts of typical cultural materials were thus secured and exported. Besides a considerable collection of identified prehistoric materials were purchased in Moravia.

Mr. Wilford, assistant to Professor Jenks, returned to the University of Minnesota the middle of June. During the summer he continued archeological work at the Minnesota Mimbres site on the Galaz ranch in southwestern New Mexico. A small amount of excavation was also undertaken in the Upper Gila culture (bordering the Mimbres on the north) and in the Chihuahua culture (bordering Mimbres on the south.)

The archeological program at the University of Minnesota is made possible over a term of years through the gift of money by interested citizens of Minneapolis. The Minneapolis Institute of Arts, as well as the University of Minnesota, shares in the materials acquired by research and purchase.

WORK OF THE SMITHSONIAN INSTITUTION

IN his annual report presented to the regents of the Smithsonian Institution, Secretary Charles G. Abbot lists a number of important achievements in the "increase of knowledge" and one material event which is certain to make possible a greater number of such achievements in future years.

That event is the authorization by Congress of an appropriation to add wings to the natural history building of the National Museum at a cost of $6,500,000. This will mean, besides increased exhibition space, many new laboratories for the preservation and study of the collections.

Of the achievements reported by Dr. Abbot is the discovery by the Astrophysical Observatory of an apparently considerable influence of short period solar variation on the temperature of the United States. That is, an average change of 0.8 per cent. in the sun appears to cause a temperature change of the order of 5° Fahrenheit in Washington. "Although this relation is complicated," says Dr. Abbot, "it offers promise of weather forecasting nearly a week in advance."

The institution's new division of radiation and organisms has made rapid progress in the construction of laboratories for physical, chemical and biological investigations. In an experiment on the amount of bending of plants towards light of various wave lengths, it was found that red or infra-red light produced no bending of the plant; that yellow light produced a small bending; that green light was one thousand times more effective than yellow; and that blue light was thirty thousand times more effective than yellow.

During the year the Smithsonian brought to a conclusion its support, which has lasted twelve years, of Dr. R. H. Goddard's experiments in designing and building a rocket to explore the unknown upper layers of the atmosphere.

Dr. Goddard's experiments are now going on in New Mexico under a gift from the late Simon Guggenheim. "It is a pleasure to record here," says the report, "that the Smithsonian has again been able to support during its more or less uncertain pioneering stages an investigation of great promise for the increase of knowledge."

In the natural sciences twenty-eight major expeditions were sent out during the year to widely scattered regions. These included expeditions to remote Eskimo and Indian tribes in Alaska by Dr. Aleš Hrdlička and Mr. Henry B. Collins, Jr.; an extended botanical exploring trip along the Amazon in Peru and Brazil by Mr. Ellsworth P. Killip; intensive collecting of mollusks in the West Indies by Dr. Paul Bartsch; as well as anthropological, biological and geological expeditions to Africa, Spain, the Philippines, China, Siam, and many parts of this continent.

The Bureau of American Ethnology excavated Indian sites in Florida and Arizona, carried on field

work among the Choctaws of Mississippi and the Creeks of Oklahoma, the San Juan tribe of California and the Iroquois of New York State and Canada. Indian music of ten different tribes was collected and much work was done in the preparation of dictionaries and grammars of various Indian languages.

The National Zoological Park during the year began the construction of a new reptile house authorized by Congress. This will permit the National Zoological Park to exhibit for the first time an adequate representation of the cold-blooded vertebrates. The collection at the close of the year numbered 2,000 animals including several species not shown in any other American zoo.

The National Gallery of Art held many exhibits during the year including one of the seventy-eight American paintings purchased during the last ten years from the Ranger fund. The Freer Gallery of Art has added a valuable variety of objects of art from countries stretching from Egypt to China.

The International Exchange Service continues its task of distributing governmental, scientific and literary publications from this country to governments and learned societies abroad, and from abroad to learned societies in this country.

THE COMMITTEE OF ONE HUNDRED AT CLEVELAND

A GENERAL meeting of the Committee of One Hundred on Scientific Research of the American Association for the Advancement of Science will be held at the Cleveland meeting to listen to reports of committees and to consider the future course of its work. The committee has concerned itself, among other things, with the conditions of the researcher as influential in the progress of research and has found in the economic status of the researcher one important condition. One suggestion for the future work of the committee proposes the careful study of a large number of American colleges and universities from these standpoints: salary adequacy, opportunity for and policy toward supplementary earnings, adequate provision for retirement, teaching load, support of research through financial support or through systematic time grants. With the information thus gained, it is suggested that institutions might be grouped into classes representing different grades of policy and of accomplishment. Such a survey would bring out institutions having promise for able researchers and those having less.

This discussion is likely to be very interesting and important. The committee will meet in the Statler Hotel at 2:30 P. M. on Tuesday, December 30.

RODNEY H. TRUE,
Secretary, Committee of One Hundred

STATISTICS OF UNIVERSITY REGISTRATION

ATTENDANCE at American colleges and universities showed an upward trend this year. The annual study of Raymond Walters, dean of Swarthmore College, published in the issue of *School and Society* for December 13, shows that the trend exceeded that of the last several years and approached the precentage increase of the post-war period.

Reports from 431 institutions of all types in every state in the Union show totals for November 1 of 578,111 full-time students, an increase of 3½ per cent. over the full-time totals on November 1, 1929. The grand total attendance, including part-time students and the summer session of 1930, is 871,184.

For full-time students the order is presented by Dean Walters as follows:

California (including the university at Berkeley and at Los Angeles), 17,322; Columbia, 14,958; Illinois, 12,709; Minnesota, 12,490; New York University, 12,147; Ohio State, 10,709; Michigan, 9,431; Wisconsin, 9,401; Harvard, 8,446; University of Washington (Seattle), 7,368; University of Pennsylvania, 7,252; Pittsburgh, 7,098; Northwestern, 6,184; Texas, 5,970; Nebraska, 5,795; Cornell, 5,725; Chicago, 5,679; Boston University, 5,606; College of the City of New York, 5,312; Yale, 5,259; Oklahoma, 5,210; University of Iowa, 4,860; Temple University, 4,736; Hunter College, 4,614; Cincinnati, 4,537.

Ranked as to grand totals, including part-time and summer students, three New York City institutions lead and another stands sixth. The grand total follows:

Columbia, 33,144; New York University, 29,214; College of the City of New York, 24,752; California, 22,797; Minnesota, 18,505; Hunter, 15,447; Illinois, 14,169; Northwestern, 14,152; Pennsylvania, 13,828; Ohio State, 13,730; University of Southern California, 13,627; Pittsburgh, 13,515; Boston, 12,713; Western Reserve, 12,450; Chicago, 11,757; Michigan, 11,756; Cincinnati, 11,454; Harvard, 10,855; Wisconsin, 10,668; University of Washington (Seattle), 10,197; College of the City of Detroit, 9,342; Texas, 9,203; Nebraska, 8,993; Temple, 8,992; Fordham University, 8,781.

The nine largest liberal arts enrolments are:

California, 9,969; New York University, 5,480; Minnesota, 4,618; Michigan, 4,214; College of the City of New York, 3,884; Illinois, 3,800; Columbia, 3,450; Harvard, 3,239; Texas, 3,184.

Among medical schools those having the largest enrolment are:

Northwestern, 740; Pennsylvania, 663; Minnesota, 659; Illinois, 576; Michigan, 573; Chicago, 546; Harvard, 517; Indiana, 439; Columbia, 430; Ohio State, 343.

SCIENTIFIC NOTES AND NEWS

PROFESSOR ALBERT EINSTEIN arrived in New York on the steamship *Belgenland* on December 11 and proceeded by way of Panama to Pasadena on December 15. Dr. Einstein was officially welcomed at the City Hall by Mayor Walker, the address of introduction being made by Dr. Nicholas Murray Butler, president of Columbia University.

THE Nobel prizes in science were awarded in Stockholm on December 11, when addresses were made by the recipients, Dr. Karl Landsteiner, of the Rockefeller Institute for Medical Research, in medicine; Sir Chandrasekhar Venkataram Raman, of the University of Calcutta, in physics, and Professor Hans Fischer, of the University of Munich, in chemistry.

FOR their work on pernicious anemia Dr. George H. Whipple, of the University of Rochester, and Dr. George R. Minot, of the Harvard Medical School, are the joint recipients of the *Popular Science Monthly's* first annual award of $10,000 "for the current achievement in science of the greatest benefit to the public." The awards and gold medals were presented on December 18, at a dinner at the University Club, New York, at which the principal address was made by Dr. Robert A. Millikan.

THE Edison Medal for 1930 has been conferred by the American Institute of Electrical Engineers on Dr. Frank Conrad, assistant chief engineer of the Westinghouse Electric and Mfg. Company, with which he has been associated for forty years.

DR. WILLIAM H. WELCH on December 12 was reelected president of the Johns Hopkins University Club for his sixteenth term.

DR. WILLIAM ALBERT SETCHELL, professor of botany, has been chosen as faculty research lecturer at the University of California for 1931. The choice was made by the academic senate on the unanimous recommendation of the committee on the faculty research lecture, consisting of the men who have had this honor in previous years. The lecture is to be given on the evening of March 24. Professor Setchell has been at the University of California for thirty-five years in his present position.

Nature extends congratulations to three fellows of the Royal Society, all of them distinguished by long and notable scientific activity, who celebrated birthdays during the last week of November. They are: Professor J. Cossar Ewart, a graduate and formerly Regius professor of natural history of the University of Edinburgh, who, on November 26, entered on his eightieth year; Professor Horace Lamb, a graduate of Trinity College, Cambridge, and formerly professor of mathematics in the University of Manchester, who, on November 27, reached the age of eighty-one years, and Sir J. Crichton-Browne, a graduate of Edinburgh, past president of the Medical Society of London, the Neurological Society and the Medico-Psychological Association, and for many years treasurer of the Royal Institution, who attained the age of ninety years on November 28.

WHILE in England recently as an official delegate to the World's Veterinary and World's Poultry Congresses, Dr. John R. Mohler, chief of the Bureau of Animal Industry of the U. S. Department of Agriculture, received an honorary veterinary degree from the Royal College of Veterinary Surgeons. In addition he was awarded the diploma of corresponding honorary member of the section of comparative medicine by the Royal Society of Medicine of Great Britain. The Hungarian Veterinary Medical Association at Budapest elected him a corresponding member.

PROFESSOR J. W. BEWS, professor of botany at the Natal University College, Pietermaritzburg, has been elected president of the South African Association for the Advancement of Science. The next annual meeting of the association will be held in July, 1931, at Grahamstown.

THE nominating ballots for president sent out by the American Chemical Society have resulted in the nomination of four members, one of whom will be chosen by the council as president-elect in 1931. These are Dr. Joel Henry Hildebrand, professor of chemistry in the University of California; Dr. S. C. Lind, director of the school of chemistry at the University of Minnesota; Dr. L. V. Redman, vice-president and director of research of the Bakelite Company, and Dr. Hugh Stott Taylor, professor of physical chemistry at Princeton University.

PROFESSOR JOHN C. OLSEN, head of the department of chemistry and chemical engineering at the Polytechnic Institute of Brooklyn, was elected president of the American Institute of Chemical Engineers at the twenty-third annual meeting held at New Orleans on December 8, 9 and 10.

THE Association of Consulting Chemists and Chemical Engineers, at the recent annual meeting, elected the following new officers: *President,* Allen Rogers; *Vice-president,* Robert Schwarz; *Treasurer,* Alvin C. Purdy; *Secretary,* Paul Mahler.

MR. BANCROFT GHERARDI, vice-president and chief engineer of the American Telephone and Telegraph Company, was elected to the presidency of the American Standards Association at the annual meeting of the association at the Hotel Astor, New York, on December 11. Cloyd M. Chapman, engineer, of New York City, was reelected to the vice-presidency.

DR. CHARLES EDWARD SKINNER, assistant director of engineering in the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania, has been nominated for the presidency of the American Institute of Electrical Engineers for the term beginning on August 1. The other nominations were, vice-presidents, W. B. Kouwenhoven, professor of electrical engineering in Johns Hopkins University; Professor W. E. Freeman, of the University of Kentucky; Paul H. Patton, of the Northwestern Bell Telephone Company, Omaha, Neb.; A. W. Copley, of the Westinghouse Electric and Manufacturing Company, San Francisco; L. B. Chubbuck, of the Canadian Westinghouse Company, Ltd., Hamilton, Ont.; treasurer, W. I. Slichter, of Columbia University. Those named for the directorate were: L. W. Chubb, of the Westinghouse Company in East Pittsburgh; B. D. Hull, of the Southwestern Bell Telephone Company, of Dallas, Tex.; H. R. Woodrow, of the Brooklyn Edison Company, Inc.

PROFESSOR ARTHUR E. HILL, of New York University, has been elected chairman of the New York Section of the American Chemical Society for 1931. He succeeds Dr. J. G. Davidson, of the Carbide and Carbon Chemicals Corporation. Dr. Davidson was named to the executive committee, other members of which are: J. G. Detwiler, consulting chemical engineer, The Texas Company; Professor R. R. Renshaw, New York University, and Dr. Foster D. Snell, consulting chemist, Brooklyn. Councillors were elected as follows: Dr. Benjamin T. Brooks, consulting chemist; Miss Marie Farnsworth, instructor in Washington Square College, New York University; Dr. Martin H. Ittner, chief chemist of the Colgate-Palmolive-Peet Company, Jersey City; Professor Daniel D. Jackson, head of the department of chemical engineering in Columbia University; Professor Arthur W. Thomas, Columbia University; D. H. Killeffer, chemical engineer of the Dry Ice Equipment Corporation; Professor Herbert R. Moody, College of the City of New York; Professor John C. Olsen, head of the department of chemical engineering of Brooklyn Polytechnic Institute; Professor Allen Rogers, Pratt Institute, Brooklyn; Sidney D. Kirkpatrick, editor of *Chemical and Metallurgical Engineering;* James W. H. Randall, consulting chemical engineer; C. R. De Long, research chemist of the Mutuelle Solvay of America, Inc.; Professor Hans T. Clarke, College of Physicians and Surgeons, Columbia University; Stephen L. Tyler, chemical engineer, The Thermal Syndicate, Ltd., Brooklyn; Frank E. Barrows, patent attorney of Pennie, Davis, Marvin and Edmonds; Charles T. Whittier, research chemist of the Royal Baking Powder Company.

As a result of the elections recently held, the personnel of the council of the Canadian Phytopathological Society for the year 1931 will be as follows: *President,* W. P. Fraser, University of Saskatchewan; *Vice-president,* D. L. Bailey, University of Toronto; *Secretary-treasurer,* T. G. Major, Tobacco Division, C. E. F., Ottawa; *Councillors,* H. T. Güssow, Division of Botany, C. E. F., Ottawa; G. H. Berkeley, Dominion Laboratory of Plant Pathology, St. Catherine's.

DR. HENRY BRYANT BIGELOW, of the Harvard University Museum of Comparative Zoology and director of the Oceanographical Institute at Woods Hole, has been appointed professor of zoology in the university. Dr. Charles Galloupe Mixter has been appointed assistant professor of surgery.

A SEPARATE department of radiology will be established in the College of Medicine of Syracuse University as the result of a grant from the Chemical Foundation. Dr. Donald C. Childs as professor of clinical radiology and Dr. Aden J. King as professor of radiological research will supervise the work in this department.

DR. C. H. CRICKMAY, assistant professor of geology at the University of California at Los Angeles, has been appointed assistant professor of geology at the University of Illinois. His term of service is to begin on February 1.

DR. C. E. LEIGHTY, formerly principal agronomist in charge of eastern wheat investigations in the office of cereal crops and diseases of the Bureau of Plant Industry, has been designated principal agronomist in charge of the office of dry-land agriculture, to fill the vacancy caused by the death of Dr. Chilcott.

MR. W. V. A. KEMP, former director of research of the committee on heat transmission of the National Research Council, and more recently research secretary of the National Electric Light Association, has resigned in order to travel abroad. Mr. Kemp will study certain engineering developments in other countries and will return to the United States in about a year.

DR. C. E. MCCLUNG has returned from South America, where he represented by invitation the biologists of the United States at the International Congress of Biology held in Montevideo, Uruguay,

from October 8 to 12. He also gave lectures and demonstrations before the faculty of medicine of the University of Buenos Aires.

Dr. Dow V. Baxter, of the School of Forestry of the University of Michigan, who recently returned from Europe, is preparing to publish the results of his study of the Dutch elm tree disease. While in Europe during the past summer Professor Baxter investigated methods being used by other governments to combat this disease.

Dr. Thomas S. Baker, president of the Carnegie Institute of Technology, Pittsburgh, is visiting Europe in the interest of organizing the third international conference on bituminous coal. He will extend invitations to well-known fuel technologists in the principal cities of Europe to attend in Pittsburgh the third congress on coal which will be held in November, 1931. Dr. Baker plans a stay of two months during which he will visit Paris, London, Berlin, Brussels and other European capitals.

Dr. P. J. Hanzlik, professor of pharmacology in the Stanford University School of Medicine, San Francisco, will give a series of lectures in Southern California from December 16 to 19. The series will include lectures on bismuth compounds in antisyphilitic therapy, metallotherapy of edema, intravenous therapy, and colloidal dyes in intoxications before the San Diego Academy of Medicine, Long Beach Academy of Medicine and Galen Club and Los Angeles Hewlett Club.

Mr. Philip H. Gadsden gave the first lecture in the eighth series of Aldred Lectures at the Massachusetts Institute of Technology on December 5. He spoke on "The Engineer's Responsibility to Society." Mr. Gadsden is vice-president of The United Gas Improvement Company and president of the Philadelphia Chamber of Commerce.

Professor H. T. Tizard, rector of the Imperial College of Science, South Kensington, lectured at King's College, London, on November 26 on "Scientific Industry as a Career."

Swampscott, Massachusetts, has been selected as the place of meeting of the American Institute of Chemical Engineers in June, 1931. The meeting of 1932 will be held in England, the city to be determined later.

The jury of award of the International Exposition at Liége has issued to the American Chemical Society a certificate showing that a diploma of honor has been awarded to the society for its journals which were exhibited at the exposition.

Plans are being prepared for the new laboratory building of the Scripps Institute of Oceanography which will be built at a cost of $120,000. The funds are provided by state appropriation, by gift from the Rockefeller Foundation and by donation from the Scripps family in equal amounts. The preliminary plans call for laboratories dedicated to dynamical oceanography and marine meteorology, chemistry, marine bacteriology and the physiology of marine organisms.

Deeds to the million-dollar estate at Huntington, Long Island, of Mrs. W. J. Conners, widow of W. J. Conners, publisher, of Buffalo, were presented on December 10 by Mrs. Conners to Dr. Reginald Knight Smith, president of the Better Health Foundation of California. Under the auspices of the Better Health Foundation of New York, a branch of the California organization, the estate will be devoted to cancer research on the lines followed by Drs. Walter B. Coffey and John D. Humber of San Francisco. Herbert L. Satterlee, of the law firm of Satterlee and Canfield, will be chairman of the executive and finance committees of the New York organization.

The U. S. Naval Observatory has issued an announcement in regard to the recent eclipse expedition, according to which three members of the United States Naval Observatory eclipse expedition who observed the total eclipse of the sun on October 21, on Niuafou Island, Tonga Archipelago, have returned to Washington with 72 photographic plates taken with the seven cameras varying from 38 inches to 65 feet in focal lengths, which were a part of the equipment used to photograph this most interesting phenomena. Commander C. H. J. Keppler, United States Navy, officer in charge of the expedition, together with Lieut. H. C. Kellers, Medical Corps, United States Navy, and Mr. Bevan Sharpless, junior assistant, carried these plates as personal baggage, in order to ensure their safe arrival at the observatory. About twenty other plates, including those to be used in a further study of the Einstein effect, are being returned to Swarthmore College by Professor R. W. Marriott, while Professor S. A. Mitchell, of the University of Virginia, is bringing 18 films taken with the powerful convex gratings of the two spectrographs. Motion picture films of the eclipse from three cameras are now being developed in New York. All scientists are extremely gratified over the results achieved, and Professor Mitchell has written to the Superintendent of the Naval Observatory, Capt. Julius F. Hellweg, United States Navy, that, in his opinion, this has been the most successful eclipse expedition ever carried out by the United States Naval Observatory. About 200 boxes of scientific apparatus and expedition equipment were carried from Niuafou Island to Pearl Har-

bor on board the United States ship *Tanager,* and will be returned to Washington *via* Navy transport. During the passage of the *Tanager* from Niuafou to Tutuila, a heavy gale was encountered and the *Tanager* was compelled to lie to for 18 hours in order to insure the safety of the eclipse records and equipment. Maximum rolls of 48 degrees to a side were recorded during the height of the gale.

THE Hydrographic Office of the Navy celebrated on December 6 a century of assistance in making navigation of the sea safe throughout the world. As a part of the program Secretary Adams delivered an address which was broadcast by radio on the history and work of the office. The centennial marks the progress made from the time the office was established under Lieutenant L. M. Goldsborough as a "depot of charts and instruments," with a working force of two officers and one nautical expert. It now has a working force of eleven officers and 180 civilians and nineteen branch offices in the continental United States in charge of twenty officers and twenty-four civilians. The office has 300,000 charts and 100,000 manuals and books ready for issue. On its correspondence list are 7,000 mariners and aviators of all nationalities. It receives information from naval vessels, American consuls, scientific organizations and foreign governments, and exchanges information with the hydrographic offices of other navies. The office also sends out by naval radio broadcast information received from the ice patrol, merchant vessels and other sources concerning dangers to navigation; conducts hydrographic surveys and maintains a section of static research which hopes through experiments to locate the centres of West Indian hurricanes soon after their formation and predict their subsequent path.

DISCUSSION

AN APPEAL FOR THE ISSUANCE OF REPRINTS OF THE TABLES OF CONTENTS OF SCIENTIFIC JOURNALS

IF scientific journals would offer for sale, with each number of the journal, reprints of the table of contents, I believe that the journals would thereby perform a real service to many of their readers and could perhaps make a small profit.

Take as an illustration the journals which are devoted partly or wholly to physics, and consider the use which an American physicist, John Smith, would make of these reprints. John Smith would not care about the reprints offered by the *Physical Review* because as a member of the American Physical Society he receives a personal copy of the *Review,* but he would consider it a distinct service if he could have placed upon his desk a reprint of the table of contents of each number of the *Proceedings of the National Academy,* the *Proceedings of the Royal Society,* the *Zeitschrift für Physik,* etc., when the number appears. Our physicist does not subscribe personally to these journals but he has access to a library which subscribes to all the journals in which he is interested. If the managements of the journals offered to furnish the reprints, John Smith and his colleagues would arrange with the library to subscribe for the desired number of reprints, and they would reimburse the library if necessary for the small outlay involved. The reprints could be sent to the library with the journal itself, thus avoiding extra wrapping and postage. The reprints would be sent only to those libraries subscribing for them say in lots of three, six, nine, etc. A dollar and a half or two dollars per year should provide John Smith with reprints from a half dozen monthly journals. He checks off upon his reprints the articles in which he is interested, and when next he has an hour to spend in the library he knows exactly what new numbers of journals have come in and what he wants to read in them. The reprints, as they accumulate, serve John Smith as a nucleus of his personal reference file. If he desires, he can have a typist transcribe the titles which he has checked to an author index or a subject index. It is far less feasible for a member of a staff to furnish a typist with the journals themselves as copy, as he must do under existing circumstances when he wishes titles transcribed.

In a university the reprints would be of service interdepartmentally. At present a man in one department must go to libraries scattered all over the campus if he wishes to keep up with the publications of some of the learned societies, as for instance those of the Berlin Academy, and with some of the journals in allied fields. But with the reprints available he would first consult the table of contents of the publications in his own library where files of these could be provided at trifling expense.

It takes little imagination to realize that the reprints would render service in several ways not at all rendered by abstract journals, such as *Science Abstracts,* which are always several months behind.

A given journal might conceivably suffer the loss of two or three personal subscriptions through supplying border-line subscribers with an inexpensive method of keeping in touch with its table of contents.

The number of subscriptions so lost would certainly be very small however. The management of a journal could recoup itself for this loss and even make a small profit by charging for the reprints several times the cost of output—and they might still be quite inexpensive.

For the reprints to be of real service to workers in one field of knowledge, most of the leading journals in that field should offer them. This would require something approaching concerted action on the part of the journals and such action will perhaps be difficult to secure.

This appeal is written with the principal object for the present of arousing, if possible, widespread consideration and discussion of the desirability of having the reprints. If, upon consideration, a large proportion of scientific workers come to believe that the reprints would be of service and should be available, then the journals would probably offer them provided the journals were apprized of the generality of this belief. Further discussion of the subject on the part of others than the writer in the columns of SCIENCE or elsewhere would no doubt help in the apprizing. Or, if representatives of departments or laboratories would write, on behalf of the groups which they represent, to the various journals whose reprints they would like to have, this would be a beginning. The journals might be induced by such letters to make inquiry among the libraries on their subscription list to determine approximately the total number of reprints wanted. However, it may develop that the very demand would require cultivation. Is it too much to hope that one or more journals may undertake this cultivation by offering the reprints over a period of years? Be this as it may, I personally feel convinced that the reprints are something we should have; if others who now feel or come to feel likewise, will put forth some small effort which they consider suitable by way of agitating the matter, perhaps we shall some day have them.

CHARLES F. MEYER

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MITOCHONDRIAL BEHAVIOR

AN article on "Mitochondrial Behaviour during the Life-cycle of a Sporozoon (Monocystis)" in a recent number (July, 1929) of the *Quarterly Journal of Microscopical Science* suggests several queries. The paper states that material was obtained from "the sperm-sacs of the common Australian (European) earthworm." "Sperm-sacs" presumably refers to those organs which oligochaetologists call seminal vesicles, although the term sperm-sac has also been used for testis-sac or testicular chamber as well as for spermatheca. But what is meant by "the common Australian (European) earthworm"? Again presumably this refers to one of the peregrine Lumbricids that have been imported into Australia and which have become acclimated in settled areas around towns and cities. But which one? At least six species of Lumbricids have been recorded from Australia: *Eiseniella tetraedra, Eisenia foetida, Allolobophora caliginosa, Bimastus parvus, Bimastus constrictus* and *Octolasium lacteum.* These worms when found elsewhere are usually present in considerable numbers, so that to each one of them the adjective common might be applied. Thus an investigator who procures his earthworms from manure piles might regard *E. foetida* as the common species, while another investigator who gets his material from the very same locality but at a distance of a very few feet from the manure piles would probably find another species to be the common form. Similarly, a thick grove or river bank only a short distance from both the preceding places might have still other common species. The phrase "the common earthworm" in such a region must therefore be nearly as meaningless as "the common bird" or "the common fish" would be. It is of course possible that of the earthworms in the vicinity of Melbourne such an overwhelming majority belong to one particular species as to justify use of the words "the common" in referring to it, but no evidence for this has been found in the literature, and even were this the case, outsiders can hardly be expected to know what the common European earthworm of Australia might be.

In this connection may I call attention to a few sentences in Stephenson's "The Oligochaeta" which, because of their situation in the preface, may not receive the consideration to which they are entitled.

> While on the subject of nomenclature, may I suggest, more particularly perhaps to some of the authors who write on physiological subjects (although morphologists are not invariably above suspicion in the matter), that they should identify, or get identified, their material? It is not nowadays sufficient to talk of "the earthworm"; there are 1,800 species. . . . "The common earthworm," too, is meaningless—what is the common earthworm in one part of the country is not so in another; while the specious appearance of exactitude given by the phrase "the common earthworm, *Lumbricus terrestris,*" is (at least as a rule) entirely fallacious.

Furthermore, the author of the paper under consideration did not state which one of the species of *Monocystis* that occur in the seminal vesicles of earthworms he studied. The importance of such systematic precautions is made quite evident by the fact that "there may be as many as five different species pres-

ent at the same time, as is the case in the seminal vesicles of *Lumbricus terrestris*."[1]

Of course, the behavior of mitochondria during the life cycle may be exactly similar in all species of *Monocystis*, but this has not yet been proved. In the meantime, until the particular species both of host and parasite investigated by the author be known, his results are invalidated by the possibility of the confusion of several species of *Monocystis*, the behavior of the mitochondria of each of which may be entirely different. As in other cases that might be mentioned, corroboration of the results obtained is impossible because of the anonymity in which the particular animal concerned is shrouded.

G. E. GATES

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RANGOON, BURMA, INDIA

BENTONITE IN THE ORDOVICIAN NEAR COLLINGWOOD, ONTARIO[1]

EXAMINATION of samples from the Robert Cherry No. 1 well on the shore of Lake Huron about 2½ miles southeast of Collingwood, Ontario, showed bentonite in one sample from a depth of 320 feet. The material is light gray, soft, with a greasy feel. In water it expanded considerably and disintegrated rapidly. The residue after panning showed pyrite with biotite flakes up to 0.2 mm with subordinate amounts of zircon, apatite and tourmaline. Dr. C. S. Ross, of the U. S. Geological Survey, confirmed the bentonitic character of the material. He reported that the structure was very similar to that of the Ordovician bentonites found in Tennessee and Virginia, more especially to that found at Catawba, Virginia, that it showed the character of fine-grained pumice and that it was similar in physical properties and in contained biotite grains. An analysis for potash made by the Mines Branch, Department of Mines, Ottawa, Canada, showed 6.08 per cent. K_2O on material dried at 105° C.

The well samples show limestone down to the bentonite bed and for 35 feet below it to the basal sandstone resting on the Precambrian. The driller reported shale at 315 to 327 feet. The sample of bentonite was quite pure. It is possible therefore that the bentonite bed is several feet thick. The well started in the Trenton limestone but below the top of this formation which, together with the underlying Black River limestone, has a thickness at Collingwood of about 550 feet as shown by well records. No fossil evidence was obtained from the samples, and the exact horizon at which the bentonite occurs is not known. It probably occurs in the upper part of the Black River limestone.

D. C. MADDOX

GEOLOGICAL SURVEY, CANADA

THE RELATION OF THE PARANASAL SINUSES TO THE SINGING VOICE

ONE of the problems encountered in the teaching of singing is the determination of the potential range of the voice. It has been a matter for the ear of the teacher to decide, and in many cases the decisions have not been correct.

Many theories have been advanced regarding this phase of vocal work, among them that of laryngeal differences. None of them have proved conclusive to any degree of accuracy.

After some years of experimental research, using the x-ray as the exploring medium, the writer has made several discoveries that seem significant.

First, that the range of the voice seems to be governed by the length of the resonating space in the frontal sinuses. Practically all the cases examined have shown a direct relationship between the range of the voice and the size and shape of the frontal sinuses, sopranos having long, narrow, frontal sinuses, mezzo-sopranos shorter and broader ones, and altos very short and almost round ones. The cases examined have run unusually true to type.

Second, the size or weight of the voice seems to be governed by the size of the antri, clear light sopranos having smaller antri than those having larger, heavier voices.

Third, the naturally beautiful voices seem to have arches, palatal and pharyngeal, that are symmetrical in their make-up, well-arched cases having more beauty in their voices than those having flat arches.

In cases where technical difficulties have been encountered by students examined by the writer and who had the advantages of study and training by excellent teachers, malformation of the frontal sinuses was apparent. In several cases a variance in the length of the right and left sinuses seemed to be the cause of irregularities in the vocal scale.

The same anatomical differences with consequent vocal changes appear in male voices.

A thorough investigation is under way by the writer, and plans are now being formed to radiograph a large number of distinguished singers' heads.

In all cases great care must be used in making all films with definite angles as the work can be accomplished only through comparisons.

Any comment, critical or otherwise, will be welcomed.

FRANCIS WHEELER

CENTENARY COLLEGE OF LOUISIANA

[1] Calkins and Bowling, *Biol. Bull.*, 51: 387, 1926.

[1] Published with the permission of the director of the Geological Survey, Canada.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MEETING OF THE EXECUTIVE COMMITTEE AT CLEVELAND, NOVEMBER 30, 1930

THE executive committee held three sessions at the Hotel Statler, in Cleveland, on Sunday, November 30. The morning session opened at 10:00, the afternoon session at 3:15 and the evening session at 8:15. Members who attended were: Cattell, Compton, Curtiss, Kellogg, Livingston, Ward, Wilson. Those absent were: Alsberg, Lillie, Millikan, Morgan Dr. H. W. Mounteastle, Dr. J. Paul Visscher and Messrs. A. J. Kennedy and A. C. Hancock, of the Cleveland group, were present at the evening session, by invitation, as was also Mr. Woodley, of the Washington office. The following items of business were transacted.

1. The minutes of the last meeting of the committee, at Berkeley, California, September 17, were reported as having been approved by mail.

2. The treasurer's report and the financial report of the permanent secretary, for the fiscal year 1929–30, were accepted. It was ordered that they be audited and presented to the council at the fourth Cleveland meeting.

3. It was voted that a special meeting of the committee on grants for research be called, with those members of the executive committee who may be able to attend, on Sunday, December 28, at the Hotel Statler, in Cleveland. The committee on grants was asked to consider at this meeting the whole problem of how the research funds of the association may be best used in the interest of the advancement of American scientific research. A report to the council at the fourth Cleveland meeting was asked for. Members of the committee on grants who attend this special session are to be allowed, in lieu of expenses, four cents a mile for the round trip and six dollars additional.

4. The special committee on the permanent secretaryship and related matters (Cattell, Livingston, Wilson) reported that 160 nominations for permanent secretary had been obtained by means of a questionnaire sent to all council members and members of the section committees. Fifty-seven favored a full-time position, of whom 37 were decidedly in favor of that arrangement. Twenty-eight favored a part-time position, of whom 9 were decidedly in favor of that arrangement. Forty-one favored retaining the office in Washington, 20 considered the location of the office as relatively unimportant, 2 were opposed to having the office in Washington.

The executive committee recommended to the council that the office of the permanent secretary be retained in Washington and that $8,000 be considered as the limit of available funds for the permanent secretaryship for next year. The special committee was asked to make definite recommendations to the council, at the Cleveland meeting, concerning the permanent secretaryship and the organization of the Washington office of the association.

5. An appropriation of $1,000 from the treasurer's funds, for use by the Committee of One Hundred on Research for the current fiscal year, was recommended to the council.

6. An appropriation of $300 was recommended to the council, for three emeritus life memberships.

7. The resignation of Dr. Rodney H. True, secretary of the Committee of One Hundred on Research, was accepted with regret. Dr. True's resignation is to be effective only after the fourth Cleveland meeting.

8. Dr. Charles A. Shull was appointed secretary of the council, to succeed Dr. Sam F. Trelease, resigned.

9. The rules for the award of the annual $1,000 prize were further amended as follows: The committee on award is to make its decision before leaving the meeting place, and public announcement of the award is to be made through the Association Press Service as promptly as possible, but not before the meeting has actually closed. The committee on award is to devote sufficient time to this decision, remaining a day or two after the close of the annual meeting. Each member of the award committee who thus stays over is to receive, in lieu of expenses, an allowance of $50. The subject of the prize paper for a meeting is to be specially presented at the next following summer meeting of the association if that is feasible, otherwise at the next following winter meeting.

10. An application for the official affiliation of the National Social Science Honor Society, Pi Gamma Mu, was received and referred to the section committee of Section K for recommendations.

11. The permanent secretary was asked to consult further concerning the best way for the association to cooperate with those engaged in dental research, especially with regard to the affiliation or association of dental-science organizations.

12. An appropriation of $3,000 from the treasurer's funds was recommended to the council, for

allotment by the committee on grants for research.

13. An appropriation of $500, or such portion thereof as may be needed, was made from the treasurer's funds, for paying the honoraria of the members of the committee on grants for research. (See 3, above.)

14. An appropriation of $250 from the treasurer's funds was made, to care for the honoraria of the members of the committee on prize award. (See 9, above.)

15. The committee looked with favor on holding the meeting of December, 1932, at New Haven.

16. A report from Dr. Gregory D. Walcott, chairman of the committee on Source-Books, was accepted and referred to the council.

17. Dr. J. McKeen Cattell was named to represent the American Association at the approaching Centenary Meeting of the British Association for the Advancement of Science, to be held at London, September 23–30, 1931.

18. Dr. Robert A. Millikan was named to represent the American Association in connection with the American cooperation with the Royal Institution, for the approaching Faraday Centennial Celebration.

19. The executive committee favored having general-interest lectures at 4:30 on the afternoons of Tuesday, Wednesday, Thursday and perhaps Friday, as general sessions of the association, also general-interest lectures at general sessions on the evenings of Wednesday, Thursday and Friday.

BURTON E. LIVINGSTON,
Permanent Secretary

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF INJECTING THE COELOM OF SMALL ANNELIDS

IN the course of experiments involving the injection of various solutions into the body cavity of Lumbriculus, a microdrilous oligochaete, some modifications of the apparatus and methods described by Knower[1] were found to be advantageous.

Small glass bulbs and tubes similar to those described by Knower, but averaging about eight inches in length and with the right angle bend one half to three quarters of an inch from the end of the bulb, were used. In this work, however, the microinjector was held in a support consisting of a wire loop so shaped that adequate freedom of movement was possible (Fig. 1). This loop was attached to an adjustable burette clamp the jaws of which held a microburner inserted into a small cork. This burner was so placed that it pointed directly toward the microinjector bulb.

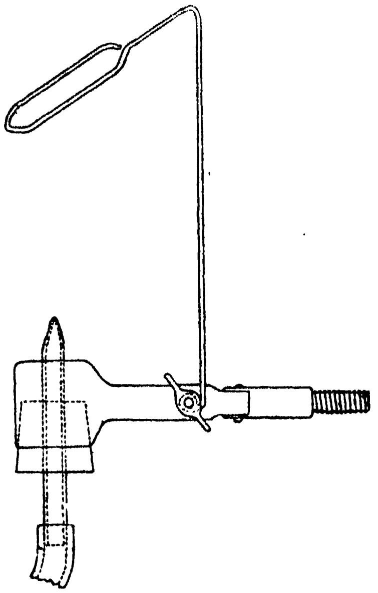

FIG. 1. Burette clamp with microburner and wire-loop-holder for microinjector bulb. One half actual size.

[1] H. McE. Knower, *Anat. Record*, 2: 207.

A rubber tubing leading to this burner was passed through a spring clamp of medium size. To keep the jaws of this clamp from completely closing down on the gas line a short piece of glass rod was fastened between them with sealing wax (Fig. 2, W). Consequently each time the clamp was allowed to close it left a small lumen in the constricted portion of the gas line. The clamp was adjusted so that when it was closed against the glass rod a flame about one half inch in length remained as a pilot light. The main gas cock was set to produce a flame which would just envelop the microinjector bulb when the spring clamp was opened. The spring loop of this clamp was slipped on the left fork of the stage of a Spencer convertible microscope in such a way that the jaws of the clamp were above and one of the finger grips rested against the upright part of the arm (Fig. 2). The clamp was held in this position by a wire wrapped around the microscope arm and slipped over the inner finger grip. In this position it could be opened by pressure exerted by the base of the index finger of the left hand, even when the other fingers were pressing down on the center of the microscope stage.

A special stage was made from a block of paraffin the ends of which had been cut so that they would

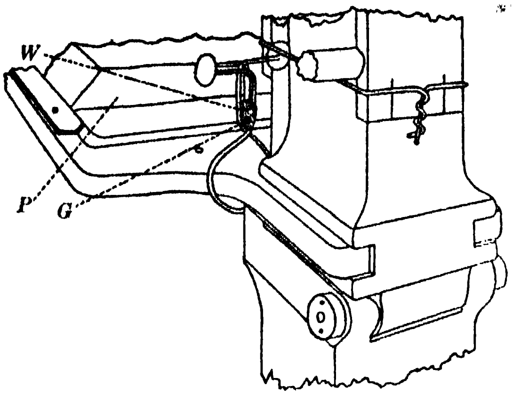

FIG. 2. Portion of binocular microscope showing method of attaching spring clamp for control of gas to microburner. Glass rod (G), held in place by wax (W), keeps clamp partially open. P, special paraffin stage.

slide under the stage-holders (Fig. 2, P). Parawax cakes are of a convenient shape and satisfactory consistency for this purpose. A straight, shallow groove, about two inches long and parallel to the front of the microscope, was cut in the center of the stage.

The injection procedure was as follows.

A microinjector, with bulb not over half filled with the liquid to be injected, was placed in the wire holder. The ring stand, carrying this bulb and the microburner, was placed at the right of the microscope at such a distance that the range of the pipette was over the groove in the paraffin stage. An individual previously anesthetized in one eighth of 1 per cent. chloretone was then transferred to the stage in a medicine dropper. After most of the solution had been removed, the worm was stretched out in the groove with the tip of its prostomium a short distance from the left end. A microscope slide or cover-glass was then placed over the anterior end of the worm, leaving several segments exposed anterior to the point at which it was planned to make the injection. A cover-glass proved the more satisfactory since its flexibility made it possible to vary the pressure exerted on the worm even though the latter did not quite fill the groove. With a few flashes of the gas flame the bulb was slightly warmed until the solution began to flow slowly in drops from the tip of the pipette. The cover-glass was then held down firmly with one or two fingers of the left hand, while with the right the end of the pipette was carefully inserted into the coelom of the worm and pushed anteriorly three or four segments from the point of entrance. Without removing either hand, the base of the index finger of the left hand was lightly pressed several times against the outer finger grip of the spring clamp to give brief flashes of heat to the bulb. If the bulb was heated too rapidly the side toward the flame became so soft that it could not withstand the pressure created within.

This method has the advantage that worms are held firmly in place while the solution is injected with a minimum of injury. The method of warming the bulb makes it possible to control carefully the flow of the injection-solution while both hands are at the same time occupied with other tasks. In addition the holder is simple, easily made and consequently more readily obtainable and less expensive than the type used by Knower.

LEONARD P. SAYLES

TUFTS COLLEGE

SPECIAL ARTICLES

THE VIRUS OF LARYNGOTRACHEITIS OF FOWLS

INFECTIOUS laryngotracheitis or infectious bronchitis of fowls has been recognized as a distinct and definite disease since 1924. The disease has become so highly destructive in the United States and Canada that it menaces the poultry industry in certain regions. There is no record of its occurrence in other countries.

The disease is now being studied with material obtained from four sources—two in New Jersey, and two in California. The poultry raising districts in California from which part of the material came have suffered severely from the affection during the past four years.

Bacteriological study having failed to reveal a consistent visible microorganism in association with the lesions of the disease, and spleens and livers, proved to contain the causative agent, having been bacteriologically sterile, a filterable virus was sought for and found in the inflammatory exudate contained in the tracheas of infected fowls.

Seven filtrations from the exudate have been made through five different Berkefeld "V" filters, and it was shown that infectious material was present in six of the seven filtrates. Of five filtrations made through Berkefeld "N" filters, three proved infectious and two non-infectious. In one of the five instances, the same material passed through a "V" filter was active. As yet no infection has been secured with material passed through Seitz filters. The incubation period of the filtrate inoculations has been the same as that of inoculations of non-filtered suspensions of the exudate.

Experiments on antibodies for the virus are in progress. Complete inactivation or neutralization of the virus has already been obtained when mixed with

serum from each of two recovered fowls, while in other instances the onset of the symptoms of infection has been much delayed.

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Department of Animal Pathology,
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THE LONGEVITY OF BACILLUS AMYLOVORUS (BURR.) TREV. IN ASSOCIATION WITH HONEY

In recent years interest in the part played by meteoric water in the dissemination of the fire blight organism has diverted the attention of some workers from the long-established[1] rôle of pollinating insects as vectors. Gossard and Walton[2] in 1922 demonstrated that the organism may be found in honey from the beehive and that it may be recovered after 72 hours from artificially infested honey.

The results of the following experiments suggest that a more detailed examination should be made of the relation of the bee and the hive to the fire blight problem.

A heavy bacterial suspension in water was made from the exudate from blighted pear twigs. This was applied with a camel's hair brush to the outside surface of a frame of honey, to the surface of the comb and to the uncovered cells at the margin of the comb. The frame was placed in a covered glass dish without the addition of water and stored in a dark cupboard at laboratory temperatures (Berkeley, California).

Transfers were made to bouillon with flamed instruments at intervals of 3, 5, 7, 9, 11, 13, 15, 20, 30, 40 and 55 days from the time the experiment was started. Inoculations were made directly from the bouillon on green pear fruits in the laboratory or apple shoots in the greenhouse. In this manner the presence of the organism was demonstrated in the honey cells in every attempt up to 15 days but in no instance thereafter. It was recovered from the wood of the frame at 3, 5, 9, 11, 13 and 20 days. From the waxy surface of the comb virulent organisms were obtained in every attempt up to 55 days when the experiment was terminated.

A second experiment was made similar to the first with the following exceptions. Undiluted bacterial exudate from inoculated pear fruits was applied to the surface of the comb only. The lid of the dish was raised slightly to provide for more ready circulation of air. Vigorous and pathogenic cultures were obtained from this source at 21 and 35 days, after which the experiment was discontinued.

Admittedly the conditions of these tests are artificial and the number of organisms was probably greatly in excess of any number likely to be introduced into the hive by the bees. The matrix in which the organisms are embedded in the exudate apparently affords decided protection of the organisms. The writer has isolated virulent organisms from rather large drops of the exudate on apple twigs, after these had been kept dry in the laboratory for 12 months (at Ithaca, New York). It seems significant, however, that the bacteria remained alive on the surface of the comb 35 days longer than was the case on the surface of wood or in the honey. Although it seems impossible to standardize the samples from these three sources, it is of interest that the growth in bouillon was in most if not all cases more profuse with the sample from the comb than with the others.

Three important questions are involved here:

1. The organisms may be carried from blossoms into the hive and thence to other susceptible plants in the neighborhood.

2. They may be transferred from one locality to another when the bees are moved for the purpose of effecting pollination in orchards. (This appears to be a rather common practice in some districts.)

3. It is possible (though it seems improbable) that the bacteria may occasionally survive in the beehive from the time of the scattered late blossoms in autumn until the first blossoms which appear in the spring.

H. E. Thomas

University of California

[1] M. B. Waite, "The Life-history and Characteristics of the Pear Blight Germ," *Proc. Amer. Assoc. Adv. Sci.*, 47: 427–8, 1898.

[2] H. A. Gossard and R. C. Walton, "Dissemination of Fire Blight," *Ohio Agr. Exp. Sta. Bul.* 357, 1922.

THE CLARIFICATION OF PLANT JUICES: NITRATE CONCENTRATION IN LARGE AND SMALL LEAVES

In view of the increasing interest in the chemical study of the expressed juice of plants, and the recent publications (Hill,[2] Cook,[3] McCool and Weldon,[4] Holtz and Larson,[5] Emmert[6]) on the determination of nitrate nitrogen in these juices, it may be of interest to describe advances in a method used in this laboratory (Gilbert[7]) for securing samples of plant

[1] Contribution No. 394 of the R. I. Agricultural Experiment Station.

[2] H. H. Hill, Science, 71: 540, 1930.

[3] R. L. Cook, *Journ. Am. Soc. Agron.*, 22: 393, 1930.

[4] M. M. McCool and M. D. Weldon, *Journ. Am. Soc. Agron.*, 20: 778, 1928.

[5] H. F. Holtz and C. Larson, *Plant Physiol.*, 4: 288, 1929.

[6] E. M. Emmert, *Plant Physiol.*, 4: 519, 1929.

[7] B. E. Gilbert, *Plant Physiol.*, 1: 191, 1926.

juice free from substances which interfere with the determination of nitrate nitrogen by the phenoldisulfonic acid method. The greatest modification lies in the elimination of carbon black, certain brands of which are known to adsorb nitrate nitrogen. The simplicity of the method should commend it to workers in the field of plant chemistry. The use of carbon black was found to be unnecessary since the colloidal complex formed by the reaction of the $Ca(OH)_2$ with the $CuSO_4$ and $AgSO_4$ adsorbs all the coloring matter present in plant juices.

Place a sample of plant tissue sufficient to yield approximately 10 cc of juice in a cheesecloth bag and freeze thoroughly for at least two hours. This is best done by solid CO_2, although an ice-salt bath may be used, if sufficient time is allowed for thorough freezing. Remove from refrigerating medium, thaw and press at once in any device which will give sufficient mechanical pressure. A hydraulic press of small size is extremely convenient for this expression, since it is essential that the pressure be the same on all samples if a comparison of the results is to be made. Collect the expressed juice, centrifuge to remove any solid material, and pipette a suitable aliquot (usually 2 cc) into a 100 cc volumetric flask.

To the juice in the flask add about 20 cc of nitrate-free distilled water; 5 cc of saturated $AgSO_4$ solution; 1 cc of N $CuSO_4$ solution, and 0.2 gram of finely divided $Ca(OH)_2$, shaking after each addition. These reagents should be thoroughly tested for the presence of nitrate nitrogen, and only those showing an absence of nitrates should be used. Make to volume with nitrate-free water, and filter after standing at least one hour. Discard the first portion of the filtrate. A suitable aliquot of this can be evaporated to dryness on a steam bath, and the nitrate-nitrogen determined by the phenoldisulfonic acid method, using NaOH to neutralize the acid according to Harper.[8] If a precipitate forms at this point, allow to flocculate and filter.

A detailed study of the method above proposed has been published.[9]

In connection with some determinations of the nitrate nitrogen in the juices of the beet plant, a significant negative correlation appeared between the weight of the leaves and the nitrate nitrogen found in the juice of these leaves. Upon further study, the correlation calculated from a statistical study of 578 individual leaves divided into twelve composite samples indicated a correlation of -0.855 ± 0.052. An explanation of this may be found in the following facts:

(1) The juice of the midrib of the beet leaf contains more nitrate than the juice from the remainder of the leaf.

(2) The ratio of the weight of leaf tissue after removal of midrib to the weight of midrib is much higher in the large leaves.

These facts offer an explanation for the correlation, for, since the high nitrate juice is in the midrib, and the proportion of the weight of midrib to the weight of the remainder of the leaf is greater in the small leaf than in the large, it is obvious that the smaller leaf should have a higher nitrate content.

In view of the above facts, it has become the practice in this laboratory to choose leaves of uniform size and to remove the midrib of these leaves before the extraction of juice for analysis. It is hardly probable that this entirely eliminates the error attributed to the size of the leaves, since considerable venous tissue remains, but it is felt that this error is much less when the midribs are discarded.

A more complete study of the above facts has been prepared, and will be published soon.

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R. I. AGRICULTURAL
EXPERIMENT STATION

THE GEOLOGICAL BACKGROUND OF PEKING MAN (SINANTHROPUS)[1]

THE *Sinanthropus* discoveries are significant for a number of reasons, quite apart from the valuable evidence they present regarding the close relatives of the anthropoid stock from which the genus *Homo* evolved. (The anatomical facts themselves are made available through the reports issued periodically by Dr. Davidson Black from the laboratory of Cenozoic Research in Peiping. Therefore, beyond brief comments on the cast of the skull and on the photographic reproductions thrown on the screen, this short outline of the salient points deals with other aspects of the discoveries, which are reported officially in the publications of the Geological Society of China.)

(1) The story of the discovery at Chou-kou-tien offers a striking example of the romance of scientific research, beginning with Andersson's studies of the Tertiary and Quaternary history of North China, and his search for fossiliferous deposits (1921), followed by Zdansky's careful paleontological work on the mammalian remains (1922), and the finding of the first teeth when the material was being prepared in the laboratory at Upsala (1926); continued by Bohlin's methodical excavation leading to the unearthing of the single tooth on which Black based the new

[8] H. J. Harper, *Journ. Ind. Eng. Chem.*, 16: 180, 1924.
[9] D. E. Frear, *Plant Physiol.*, 5: 359, 1930.

[1] Abstract of paper presented at the meeting of the British Association, Bristol, by permission of the director of the Geological Survey of China.

genus *Sinanthropus* (1927); carried on by Pei's further discoveries of teeth, jaw and skull fragments (1928), and culminating in the finding of the uncrushed skull on December 2, 1929; and the reconstruction of the second skull six months later.

(2) Unlike the scanty remains of *Pithecanthropus* and *Eoanthropus* the material available in the case of *Sinanthropus* represents parts of ten individuals. It is surprising that all the material recovered is from the head, no limb bones having been so far recognized.

The most perfect skull is complete down to the roof of the orbital cavities, and has unfused sutures, being of a young adult.

It may be added that no stone implements or other sign of culture have been found.

(3) The main fossiliferous deposit occupies one of a series of old caves following former underground solution-channels in tilted strata of Ordovician limestone. It consists of a series of roughly stratified reddish sands and gravels, locally cemented into a tough travertine, mixed and interlayered with gray limestone breccia, due to the progressive collapse of the roof as the floor was built up. Probably at no time was the open cavity as high as the present depth of the deposit. The latest finds owe their preservation to the protection of a choked lateral conduit branching from a low level in the main cavity.

(4) As a minor point may be mentioned the accessibility of the locality. Chou-kou-tien is a village on the edge of the Western Hills, 45 miles from Peiping, which, on account of its coal, limestone and granite, is served by a branch of the Peking-Hankow Railway. Though not of use for passenger service, this railway has allowed the removal of great quantities of unprepared fossil material which can be carried away in bulk, to be worked up in the laboratories in Peiping. During the seasons 1927–29 1,475 cases of fossils were taken out in this manner. In addition, the quarrymen of the place are available for the task of blasting out the limestone and travertine walls, and excavating the less consolidated parts of the deposit in which the fossils occur. Thus, during the same three seasons a total of 8,800 cubic meters was excavated, despite the fact that the countryside has undergone a period of severe military and political disturbance.

(5) Parts of *Sinanthropus* have been found at five distinct levels, separated by as much as 60 vertical feet of deposit. The same is true of much of the mammalian fossil material, thus showing that the entire deposit is essentially of one and the same geological age. There is thus no chance of error in dating any particular horizon within the body of the deposit.

(6) The faunal assemblage is very rich, well preserved, varied in character, and suited to exact dating in terms of Chinese geological chronology, as well as of value in determining the climatic and environmental habitat of the period. Over fifty mammalian types, besides frogs, snakes, turtles and birds, have been already distinguished, and when comparative studies have been made should permit of close correlation with fauna in other parts of the world. Most characteristic types are *Sinanthropus* ("Peking Man"), *Euryceros* (flat-antlered deer), *Rhinoceros*, cf. *sinensis*, *Hyaena sinensis*. Interesting types are the big beaver (*Trogontherium*), primitive buffalo (*Bubalus*). There are suggestions of a southern affinity. It is distinctly older than the Loess fauna (Middle Pleistocene), which includes *Rhinoceros tichorhinus*, *Hyaena crocuta*, *Cervus elaphus*, in place of those mentioned above. The general assemblage is Villafranchian in type and can be closely dated as very early Pleistocene in view of the absence of truly archaic types, and the presence of modern types, including *Equus*; but it is definitely distinct from and older than Middle Pleistocene. This age tallies with the physiographic and climatic stages as determined from entirely independent evidence in other localities in North China.

(All new data are issued from the Laboratory of Cenozoic Research under the control of the Geological Survey of China and the Peiping Union Medical College. A bibliography up to December, 1929, appears in a paper by Teilhard and Young in *Bull. Geol. Soc. China*, Vol. 8, No. 3, 1929. Further data appeared in Vol. 9, No. 1, 1930.)

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WHAT THE TECHNICAL SCHOOLS EXPECT OF INDUSTRY[1]

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THE topic which the distinguished president of Lehigh University has invited me to discuss on this occasion is "What the Technical Schools Expect of Industry."

Permit me to suggest that before we discuss a "What" we should reflect on and disclose whether there may or may not be a reasonable "Why." That is, we should consider whether there are reasonable grounds on which the men who control the scientific and pedagogical processes and progress in the engineering schools can establish a just claim on the intellectual and financial interests of industry. Permit me to diverge briefly and dispose of this question, in the interest of then being able to more clearly unfold my principal theme.

[1] Address delivered on the occasion of the dedication of the James Ward Packard Laboratory of Mechanical and Electrical Engineering, Lehigh University, October 16, 1930.

The application of the words "industry" and "industries" in this address is to the engineering industries, and these words thus used are inclusive of substantially all collectivities engaged in manufacturing, transportation, generation and distribution of power, production of artificial light, communication of intelligence over distances. These compose the broad foundation which, next to sentiment, ethics and religion, supports our twentieth century civilization. Even agriculture, a basic and pervasive activity, now secures part of its character from these engineering industries through the inventions that have given birth to automobiles, tractors, hard-surfaced roads, manufactured fertilizers; in addition to the older railroad, electric light and power, and telephone industries. We thus are discussing a topic which touches the welfare of every ultimate citizen. The wise administration, the continued unfolding of new aspects, the

prosperity of the engineering industries, are the concern of every individual among all classes of citizens, rich and poor, exalted and lowly, alike. That discloses a responsibility and a scope in the industries sometimes overlooked, which gives one side of the answer to our "why." Engineering works provide the veins, the nerves, the sparkle and the vital functions which vitalize modern civilization. Agriculture continues to provide the food supply. The government has found it necessary to furnish guidance and support for the functions of higher education and research in the latter. Industry is able to cooperate in the support of these functions applied to the former, and better progress can be made where industry embraces its part in the cooperation and by its achievement illumines the features that economically may be supported by government.

With our abundance of opportunities for new or improved utilization of forces and materials and preventing waste of man-hours and natural resources, the prosperity and influence of the industries are bound up in improving on the old, well-beaten, wasteful paths of practice which have been determined solely by empiricism. For the supply of men to be relied on in development—the unfolding of new fields and improvements in the old fields—industry has come to rely more and more on the colleges and particularly the engineering colleges. This is another side of the answer to the "why." Engineering school men are coming more and more into elevated administrative posts where wise administration must be in command, in addition to carrying on in the designing, manufacturing and selling branches of industry. Scientist or engineer can become a great merchant if he has the taste and will to be. The business man who is pure empiricist has proved to be more than 50 per cent. failure. Creative intelligence in management and ability in scientific research are two assets for a people that can not be too highly valued. On our success in stimulating them we may confidently rest our future.

Development in the industries is largely the result of additional applications of well-established science or (less frequently, but often most fruitfully) of applications of newly discovered facts or modes of reasoning. For making the discoveries, industrial society must largely rely on the school men. The universities in all their branches, including the engineering schools, are educational institutions and the making of men (a pedagogical process) is a primary function for them, but research is an important parallel function both as a part of the pedagogical process and as a means for testing empirical philosophies and extending knowledge by discovery. The engineering schools are proved to be capable and successful in the prosecution of these two functions; the products of these functions are highly important to the financial prosperity of industry. This is a third side of the answer to our "why." We of the engineering schools believe that these *a priori* grounds make a sound reason for industry to contribute financially for the purpose of aiding the engineering schools to improvement in prosecuting these functions, but to direct such contributions only to such schools as are qualified by the possession of the spirit of progress.

Engineering education has for its end result the attainment of knowledge of the ways of nature and man, intelligence in the command of circumstances, resourcefulness in the use of knowledge, a spirit of investigation into the phenomena of nature, powers of exact analysis and synthesis, and an instinctive sense of the relative fitness of things. The days of the old-time empiricists who carried on according to the ways of their fathers solely because their fathers did so before them are almost gone in engineering and the engineering industries. The days of intelligent application of science and the now known principles of economics have dawned. The necessity of widening the applications of science and of farther disclosing applicable economic principles is recognized in engineering and has become a factor of engineering education. The pinch of necessity seems always to produce improved intelligence; which is a corollary of the theorem that the fittest in intelligence survive and radiate their influence to the ends of the earth. No education is directed to a finer end.

Before going farther it is reasonable to search our souls with the inquiry whether we of the engineering schools are performing the two functions of the making of men and of prosecuting research in such a devoted and impartial manner that support of the performance from industry at large may be justly expected. Have we thrown empiricism sufficiently to the winds in our processes and joined the band of scientists and economists who pursue, disclose and correlate all facts, endeavor to discover new facts, and fit all together in an intellectual and physical embodiment without being overly-trammeled by tradition? If we have not, then we must step forward under internal compulsion before relying much on external support.

Our alumni and others of either sex who advise their sons and the sons of friends to become our students have the right to inquire into our ways. They may ask whether we thoughtfully assay our pedagogical methods and strive to elevate their quality; whether we suitably recognize those distinctions be-

tween students which arise from present differences in intellectual maturity and speed, and encourage the development of each student to his fullest individual capacity; whether we encourage exercise of each individual student's self-reliance and resourcefulness; whether we secure reasonably complete intellectual contact between students and faculties to aid in enriching the sense of responsibility, loyalty and character of every student; whether we utilize a fundamental and scientific approach in the subjects pertaining to our teaching and also in the formulation of our curricula; whether we appreciate the importance of placing empiricism in engineering in a less important place in our teaching and utilizing it only to fill up gaps left by the inadequacy of the organized knowledge known as science; whether we are achieving a closer articulation of the principles of economics with those of science; whether we are developing a sound investigative spirit in all our students; whether we are associating formal scientific research with mature students' work so that students may know by experience the effectiveness of a sound marshalling of facts as a basis of judgment instead of much that goes by the name of judgment but in reality is merely guessing; whether we are bestowing wise selection and supervision on younger members of teaching staffs and are seeking to establish greater selective rewards in the way of distinction and financial compensation for established achievement by staff members; whether we all embrace the golden tenet that pedagogy and scientific research should be bedmates in engineering education.

Frankly facing the situation, we can see the need for improvement in the aims and practices of the engineering schools. Nevertheless, their educational ideals and practices are unexcelled in the field of higher education in the United States. Our logically coherent curricular programs, set out in sufficient variants to satisfy the intellectual tastes of the variety of students who choose to enter the field of engineering, associated with freedom of election and substitution by individuals who have reached the maturity to demonstrate fitness for making their own "case," have been a steadying and rectifying influence in national higher education. Moreover, we know that improvement in our processes is being made and will continue to progress.

Although such questions as those enumerated in the second preceding paragraph may be asked justly by patrons of our students and supporters of our engineering schools, there is nevertheless an amplitude of evidence of successful results rising out of our performance to plentifully answer our "why" and justify a claim for selective support far larger than has yet been extended to engineering schools by the industries. This is shown by the reports of the recent comprehensive analysis of aims, processes and results of the engineering schools made by committees of the faculties under a coordinating committee (called the Board of Investigation and Coordination) which was appointed by the Society for the Promotion of Engineering Education. Financial support supplied by the Carnegie Corporation for a director of investigation with his aides and headquarters made this important study possible.

Time lacks for me to give a full exposition of the undischarged debt of industry in this country to the engineering schools. I must now content myself with a few briefly stated illustrations.

Aside from distinguished inventors and executives who laid the early part of the structure, many of whom continue in great achievements but whose days of youthful education were over before the engineering schools sensed the importance of industrial development, it is a matter of commonplace observation of the electrical industries that a notable proportion of the men in executive or developmental positions who are now advancing these industries to greater service, influence and prosperity are alumni of engineering schools. As far as these industries are of value to the citizenry of this country by increasing the comforts and conveniences of life and by enlarging the hours of leisure, so far the citizenry have a debt to these men and a debt to the engineering schools from which many of the men secured education and stimulation in their youthful days. As far as the vision of these men has contributed to the prosperity of the industries, these industries, their employees and stockholders also owe some debt to the engineering schools for the contribution of their part in the education of these men.

The executive and operating affairs of many of our most prosperous and serviceable railroads are in the hands of men whose youthful schooling was in some engineering school and from the fertilizing influence of which the individual's present ideals and ambitions may have been aroused. The steel industries are slowly turning from empiricism to engineering science for the betterment of their methods. The textile industries located in New England might well have been in a happier condition to-day, had they not notably lacked in the scientific spirit characterizing engineering in this generation.

Mr. James W. Gerard (former American ambassador to Germany) recently came forth with a list of names of sixty-four men who, he was reported to allege, "rule the United States." The list was marshalled in argument supporting a special cause and

Americans speedily denied the possession of his selection of the power to rule this nation. However, it is sufficient for our own purpose here to agree that each of the names in that list attaches to a man of magnificent achievement who is in high and useful influence in finance, commerce, industry or social relations; and that every one, whatever his primary leaning may be, has had a large influence directly or indirectly in establishing, widening or increasing utility of the output of industry in this country. It is a pertinent fact that 17 per cent. of these men are engineering school men. The proportion of engineering school alumni among the total of ambitious men in this country is much smaller than 17 per cent., and some decades ago, when these men on Mr. Gerard's list were entering industrial life, the proportion was still smaller. It appears from this list, as far as such a list may have pragmatical weight, that the engineering school processes in education have a proved vitality. Creative intelligence in management is a triumphant but elusive fairy; however, she is no will-o'-the-wisp that can not be captured as an embodiment. In fact, she seems to favor association with the educational processes which characterize our engineering schools.

With this academic year I enter upon my fortieth consecutive year as head of a department of electrical engineering, first at the University of Wisconsin, beginning when electrical engineering instruction was established in that institution, and latterly at the Massachusetts Institute of Technology. This long period of employment in these two great universities has afforded unrivaled opportunities for observation and reflection on the development and status of engineering education. In the earlier days, the engineering schools were looked upon askance alike by the industries (on the ground of alleged lack of "practicalness"), and by the so-called liberal colleges (on the ground of alleged "narrowness"). Among the engineering faculties we were far from agreement on aims and differed radically amongst ourselves regarding the relative weight to be attached to exact science, scientific research and formulated economics, as supported by one group, and empirical engineering practice as supported by another group. Latterly these fogs have blown to one side. Experience has disclosed the relative merits and demerits of the principles supported by the different parties in engineering education.

Our vision now is clearer and more far-reaching. Our educational processes stand unexcelled in results and in repute. Fully awakened to the importance in education of utilizing scientific research, we emphasize the science, scientific research and economics in our curricula. We use empirical practice as material out of which to build illustrations and contrasts among the present applications of scientific methods in engineering, to demonstrate possibilities of the betterment of practice through the fruits of research, and to map paths that may lead to such fruits if unswervingly followed. Influences of this nature, though then quite crude, are the influences under which were placed as students that 17 per cent. of Mr. Gerard's list who are engineering school men, considering one by one these men and the engineering schools in which they studied.

In the engineering schools, we believe that engineering is second only to preventive medicine in influences which improve the comforts of populations and widen to all individuals the opportunities for desirable living. We men of the engineering faculties believe that there is a steadily enhanced popular approval of (1) our pedagogical ideals, (2) our methods of scientific research, and (3) our linking the one with the other for the purpose of making scientific inquiry an incident part of man's education in preparation for an active, resourceful and creative life. The emphasis on scientific research is not wholly to train research men in the technical sense of cloistered laboratory discoveries, but the emphasis in the engineering schools is for the wholesome pedagogical influence which breeds an investigatory spirit. Engineering schools are in fact fitting a due proportion of men for scientific research of high order, but through their methods they are likewise fitting for the engineering industries men who are capable of ultimately assuming with distinction posts in scientific designing, manufacturing, salesmanship and administration according to the tastes and maturing experience of the individuals.

It also appears to us of the engineering schools that the direct incidence of our former students on the development of the industries has been for the good of the industries and for the people of the country. If the foregoing interpretations are correct, and we believe them to be, we have every reason to expect from the industries a fuller recognition than has yet been accorded. *Well-directed recognition will be approved by the people of this country, who (broadly speaking) are the consumers of industrial products and many of whom are stockholders. Well-considered support of the engineering schools by the industries is sentimentally as well as legally sound.*

Specifically and not exclusively, the engineering schools expect of industry many things, as industry on the other hand has come to expect many things of the engineering schools. Differences defined by territorial relations, industrial unities and scopes of individual schools arise to modify whatever claims of

expectation are put forward. However, I will risk some categorical suggestions. These are in somewhat dogmatic form but are expressed with a full sense of the friendly relations that exist between the engineering school faculties and leaders of industry, to an extent that is fast bringing us to see eye to eye on educational questions.

The engineering schools expect industry to recognize the duty of the schools (pertaining to them as educational institutions) of independence in thought, in subjects and methods of research, and in opinions. In return the faculties should recognize a duty to refrain from spreading inadequately founded opinions and from dogmatizing in controversial fields.

The engineering schools expect industry to recognize the importance of independent creative scientific research as part of the life of the faculties and students and to support it with contributions of money and counsel made to those schools that are adequately manned and equipped, to the end that additional knowledge may be disclosed out of which industry may forge new applications; and also to recognize the importance of such research as a pedagogical instrument in those schools that are manned and equipped to properly carry it on. Special investigations and researches for an industry that may be carried out in a school with free relation to students and with the understanding that the results may be published may be mutually useful to school and industry, even if a staff adequate for consecutive work on independent research is not available. Having routine tests made, and having special confidential researches carried on, in the engineering school laboratories, is a privilege that industry may claim and expect to be allowed, but this absorbs the intellectual power of members of the faculty and the time of equipment without recompense through student relations or publication of results; and this should be compensated for by money contributions which may be applied to independent research carried on in contact with well-advanced students.

The engineering schools expect large industrial establishments to pay more attention, in their own interest, to the articulation of recent graduates into the industrial work for which they are employed. With few exceptions the present practice is to fit these new employees into places requiring very limited needs, and to make no provision for such employees to gain (except by chance) an understanding of the accomplishments expected of them, thus leaving them "wallowing around" for months without light or leadership which often ends in atrophied resourcefulness and ambition. Supporting the use in the larger engineering schools of formal curricular enterprises led by engineers from industry, like the senior Colloquia in electrical engineering at the Massachusetts Institute of Technology, would fruitfully serve in improving this situation.

The engineering schools expect that the personnel problem of employing young men who are on the eve of completing formal study in the schools will be dealt with by the employing agents of the industries in a judicious and discriminating manner.

The engineering schools expect to clasp the hand of cooperation and not of domination where the employees of industry contact with engineering school faculties or students.

The engineering schools expect that leading men in industrial organizations will take cognizance personally of these needs to the end that the tenets may be vitalized; that dominant industries will recognize a special interest in supporting these tenets; and that associations of industries will also recognize a cooperative responsibility.

The engineering schools expect that industry will aid in laying before the public a fair statement of the public interest in continued industrial development and invention, and the need of maintaining independent research in the engineering schools in order that a stream of results may be available as raw material out of which to mould further industrial development and invention; to the end that the public may come to realize the propriety of industry making contributions of generous size to selected engineering schools for the support of independent research in those schools.

It is also reasonable to expect that men in industries will aid by directing to the engineering schools suitable young men who as students will persistently maintain high scholastic and character levels; who also possess at least incipiently appropriate qualities of personality and ambition, including fixedness of purpose.

The research relations between the engineering schools and the industries are being aided by the division of engineering and industrial research of the National Research Council. Industrial executives are giving increasing recognition to the value of research as a tool of modern industry. Economic pressure arising from competition is driving many industries into extended research activities as a protective and progressive measure. The increase from 500 definite industrial research laboratories in 1921 to over 1,500 in 1930 weaves the picture of this new economic trend. Small firms which are not prepared to create individual research centers for themselves can carry on by means of industrial fellowships in laboratory or-

ganizations maintained by educational institutions or government departments, or by means of research laboratories under the control of their own trade associations. On account of the development now in progress, the National Research Council Division referred to is appropriately turning its promotional efforts from "why do research" to "how do research," and plans are under consideration for bridging the gap between industry and educational institutions by means of conferences between leading institutions and industrial executives—also bringing the trade associations into the plan because they undoubtedly have a helpful influence for small companies.

The Division already has examples of such endeavors. Thus, in the welding field some ten leading institutions are undertaking investigational work of specific problems with coordination through an appropriate committee. Specimens needed in the investigational work are made up by industry under the exact conditions required by the laboratories. Special apparatus is supplied where needed. Some of the smaller companies, and even some of the larger ones, will find that for certain types of work the educational institutions will return more accomplishment for the research dollar than can be obtained in any other manner. But it must be remembered, in educational institutions and in industry, that mere projects of testing are not research, while it is the latter which brings progress and prosperity to industry.

The relation between any typical industry and the engineering schools can not be nationally uniform or nation-wide. Selectivity and discrimination (in the sense of recognition of fitness) are necessary to avoid waste of money and effort in cooperative relations which grow up between the industries and the engineering schools. In the engineering schools, we should aim to make our efforts at industrial cooperation primarily with those industries which have establishments within nearby territory and whose interests lie principally within the range of our individual school curricula and equipment, but the sources of our students may be world-wide and the employment of men who take our degrees may be nationally spread. The engineering schools expect individual industries to give their cooperation primarily for their own welfare, but additionally because it is for the best interest of processes of higher education which associate generally with the industrial welfare of the country. The engineering faculties devote their lives to work of beneficial interest to the industries and it is reasonable for the faculties to expect constructive cooperation and aid from the industries.

OBITUARY

WILLIAM DILLER MATTHEW, PALEONTOLOGIST

(1871–1930)

THE death of William Diller Matthew on September 24, 1930, cut short at the height of his career a man who had contributed immensely to the science of paleontology, one who realized the value of this science for the philosophy and art of human living and who was in the midst of a sustained and highly successful effort to open wide its broad fields, especially to great numbers of his own well-trained students.

In 1894 Matthew was a red-cheeked Canadian youth in the department of geology at Columbia. His main interests at that time were in crystallography, in trilobites and in the structure of the intrusive and effusive rocks of his native country around St. John, New Brunswick. His father, George F. Matthew, was an amateur geologist in the best sense, since he was a recognized authority on the geology, fossil plants and early amphibian footprints of New Brunswick. His mother successfully reared a large or "old-fashioned" family and imparted to all her children her irrepressible cheer and good humor, as well as her high ideals of service. Fire consumed the elder Matthew's collection of fossils and his scientific library; but he set to work to build them up again. The son was a young man of almost Spartan simplicity of life: frugal and self-denying but early learning to achieve excellent results with slender resources.

With such a background the young Matthew, after obtaining his doctorate at Columbia in 1895, came to the American Museum of Natural History at the invitation of Professor Henry Fairfield Osborn to be a scientific assistant in the then young department of vertebrate paleontology. His first big task was to go down to Philadelphia to catalogue and pack up for shipment the great private collection of vertebrate fossils which had been amassed by Professor E. D. Cope, and had recently been sold to the American Museum. In this way Matthew gained his first extensive contact with Cope's life-work and collection. During the next thirty-five years it was his lot to catalogue and identify tens of thousands of vertebrate fossils for the ever-growing collections of which the Cope collection was the foundation. More cautious than Cope and far more critical, with the advantage of great stores of additional material, he corrected, revised and extended Cope's work in many

fields, conserving and strengthening as much as he reasonably could of Cope's results. For instance, in all his extensive researches on the classification of the Eocene carnivores he clung tenaciously to Cope's definition of the Creodonta, which had been so framed as to include both the typical specialized creodonts and their differently specialized relatives, the ancestors of the higher carnivores. This was not because he doubted the ancestral kinship of the miacid creodonts to the higher carnivores but simply because, like Cope, he was a stout defender of the "group method" of classification, which insists on the formal definition of groups of related organisms that possess in common the characters cited in the definition, this method being in opposition to the "phylogenetic method," which defines "phyla" according to their supposed trends of evolution and which includes in these phyla even the earliest and little-differentiated representatives that have not yet acquired all the visible characteristics of their descendants. For example, the earliest so-called "horse" (*Eohippus*) is so closely related to the earliest so-called tapir (*Systemodon*) that even Matthew and his colleague Walter Granger have found it difficult to distinguish the molar teeth of certain species of *Eohippus* from those of a certain species of *Systemodon* (= *Homogolax*). From this and other evidence Matthew contended that these two closely related genera along with many other related forms of Eocene perissodactyls, including the ancestors of the paleotheres and rhinoceroses, ought to have been referred to a "horizontal" family, the Lophiodontidae. This family would have been defined by the retention of many primitive dental and skeletal characters which were subsequently lost by their divergent descendants the paleotheres, horses, titanotheres, rhinoceroses, tapirs, etc.

Another instance of his conservative progressiveness may be found in his most widely known work, "Climate and Evolution" (1915). Being a student of Alfred Russell Wallace's works on geographic distribution, he sided with that great naturalist in opposing those who lightly reconstructed "land-bridges" across the oceans of any and every geologic epoch in order to account for the presence of related animals and plants on opposite shores of ocean barriers. From his vast and intimate knowledge of the fossil record of the vertebrates, he was able to show that many groups whose representatives are now found dispersed in far distant tropical and southern continents are the specialized descendants of known fossil types which in the Eocene and later epochs were inhabitants of the northern lands. His excellent distribution maps were "North Polar projections" of the continental land masses, upon which was plotted: first, the distribution of the Eocene and later ancestors of the horses, tapirs, rhinoceroses, camels, pigs, ruminants, dogs, cats, etc., which were all known only in the northern hemisphere; second, the present distribution of the scattered representatives of many of these families in tropical and southern land masses. His inference was that these forms had originated in the northern hemisphere, had then spread southward into the tropical and southern countries, while the original stock often became extinct in the northern homeland.

On the geologic side he adopted the theory of isostasy, in so far as it was developed at the time. According to this theory, the continents and oceans are held in balance in such a way that only minor oscillations of level have occurred; thus, although the land was at intervals submerged under shallow invasions of the sea, while at other times the continents emerged to higher levels, yet the main continental masses have remained substantially intact, at least throughout the period covered by the records of vertebrate life. In order to account for the first colonization by mammals of continental islands, including Madagascar, Australia, New Zealand, he followed Wallace in evoking the agency of those "natural rafts," which emerge in great numbers from continental rivers and carry sometimes a stray small mammal. Once in a million or more chances, he argued, this castaway might be a gravid female whose progeny could subsequently colonize the whole island. He cited the evidence that tended to support the view that even the most gigantic Australian marsupials had been derived eventually from small arboreal ancestors, which were the only kind that might be conceived to be capable of living in a tangled mass of vegetation during its long drift across the sea and through subsequent perils of landing on a strange shore.

Thus Matthew came to deny the validity not only of all the supposed sunken "land-bridges" across the Atlantic and Pacific which had been evoked by various authors, but also the supposed former connections of South Africa, Australia and South America with the Antarctic continent. Accordingly he ascribed to "parallelism" the rather striking resemblances of the extinct "sparassodonts" of Patagonia with the existing thylacines of Tasmania.

Whatever may be the ultimate verdict of science upon these features of his zoogeographical theory, it is somewhat unfortunate that this more or less debatable aspect of his work should have been discussed by dozens of writers of varying competence, while his immense contributions to the orderly development of mammalian paleontology were really well

known only to those two or three specialists who, with fossil specimens in hand, wanted to identify their material by comparison with his excellent descriptions and figures.

The greater part of his scientific writings deals with the revision of mammalian fossil faunae, including the Basal Eocene Puerco and Torrejon, the Lower Eocene Wasatch, the Middle Eocene Bridger formations of the Eocene and many horizons of the Oligocene and later Tertiary. To all these faunae he contributed extensive technical reports or memoirs. His faunal lists of the Tertiary horizons of Western North America, though embodying the work of his predecessors and colleagues, nevertheless represented his own labors in identifying thousands of fossil specimens; they were also based upon his personal studies of the precise geologic level of specimens collected in field parties under his direction.

He was always a geologist as well as a paleontologist and geological considerations occupy a good share of his published writings. As a result of his field and museum experience he successfully attacked (1899, 1901) the theory that the deposits of the supposed ancient "Lake Basins" of the West had been laid down in great lakes, showing that the geological and paleontological facts indicated rather the derivation of these formations by flood-plain playa and aeolian deposition.

His conclusion that the Basal Eocene formations of New Mexico and Wyoming represented a very long period of time (to which he gave the name Paleocene) between the Uppermost Cretaceous and the true Eocene has recently been confirmed by the intensive explorations carried on in northwestern Wyoming by parties from Princeton University.[1]

Owing to the great scarcity of fossil mammals, except in a very few museums, and to the necessarily technical nature of most of his work, Dr. Matthew's greatest discoveries concerning the evolution of the mammals were known at first hand only to his immediate colleagues and to a very few specialists scattered over a world which, for the most part, is impervious to paleontological science. But, as practically his entire scientific career was spent amid the most compelling evidences of evolution, it is not surprising that when he did write for the public on the subject he was able to do so with conviction and with authority. His vigorous honesty and cautious testing both of fact and of inference inspired confidence in the reader. Among the most important of these writings on evolution were his popular "guide" to the evolution of the horse[2] and his admirable articles on the evolution of the horse family and of the dog family,[3] his summary of the evolution of Eocene mammals in the Proceedings of the Zoological Society of London (1928), and especially his handbook "Outline and General Principles of the History of Life."[4]

In 1927 Dr. Matthew accepted the call of the University of California and went there to be head of the department of geology, professor of paleontology and director of the paleontological museum. He was brilliantly successful in attracting very large numbers of students to his lectures in spite of the difficulty of his courses; he also stimulated new exploration and research and attracted young men of great promise into the field of paleontology. In the summer months he came back to his old collections in the American Museum to continue and complete his monograph on the Paleocene mammals. But in the midst of all these successful activities he was interrupted in May of 1930 by the first serious indications of the grave illness to which he finally succumbed after a long fight. He is survived by his widow, two daughters and a young son.

In fine, Dr. Matthew's greatest contributions to the cause of science and enlightenment may be summarized as follows:

He identified, catalogued and kept in close touch with tens of thousands of specimens of fossil mammals. He took part in and directed field exploration in many western localities and in Florida, and made extended studies of vertebrates in the museums of Europe and in the field in Mongolia, Java and elsewhere. With this background of practical experience he compiled, and repeatedly revised and extended, faunal lists of all the Tertiary horizons of Western North America and took a prominent part in correlating the horizons of different localities with each other and with the faunae of Europe, Asia and other regions. He published a long series of memoirs, bulletins, *novitates*, etc., on the fossil mammalian faunae of North America, especially those of the Puerco and Torrejon, Tiffany, Wasatch, Bridger, White River, Lower Harrison, Rosebud, Sheep Creek and several later formations. In these reports he dealt effectively with the stratigraphic relations of the formation, mode of deposition, ecology of the various groups, revision of species and genera, osteology and allied topics.

In the course of the foregoing and other work he made significant contributions to the classification of mammals and knowledge of phylogeny in nearly all the orders and suborders of mammals, but especially the Creodonta, Arctoidea, Aleuroidea, Insectivora,

[1] Jepsen, G. L., *Proc. Amer. Philos. Soc.*, lxix, p. 467, map.

[2] *Quarterly Review of Biology*, Vol. 1, No. 2, April, 1926.

[3] *Journal of Mammalogy*, Vol. 11, No. 2, May, 1930.

[4] University of California Publications, Syllabus No. 213, 1928.

Rodentia, plesiadapids, lemuroids, tarsioids, ganodonts, teniodonts, Xenarthra, Condylarthra, Taligrada, Amblypoda, Hippoidea, Rhinocerotoidea, bunodonts, bunoselenodonts, Tylopoda, hypertraguloids, Pecora. Even in a much fuller review of this aspect of his work (to be published elsewhere) it has been impossible to do more than touch upon a few of the evolutionary problems which he either definitely solved or left with significant enrichment. It must suffice in this place to state that the younger generation of American paleontologists, which is now fortunately coming forward, is already finding that Dr. Matthew, while giving final answers of fact to thousands of specific questions, has also bequeathed to them other thousands of problems that will challenge their best efforts for a lifetime.

WILLIAM K. GREGORY

FRITZ PREGL

PROFESSOR FRITZ PREGL, head of the Institute of Medical Chemistry at the University of Graz, Austria, died quite unexpectedly on December 13 at the age of 61. Professor Pregl was the originator of the methods of quantitative organic microanalysis bearing his name, which have found so widespread application in recent years. In recognition of the eminent practical importance of this work he was awarded the Nobel Prize in Chemistry in 1923. Pregl originally received a medical training and was actually practising in ophthalmology, but later turned back to the preclinical sciences and became interested in certain physiological-chemical problems. This inclination brought him in contact with K. B. Hofmann, Abderhalden and Emil Fischer and resulted in a number of publications on various subjects (bile acids, composition of proteins, starch). In the course of an investigation on bile acids lack of material put before him the choice of either abandoning the problem or of inventing new methods of analysis. Within a few years (1911–1914) he was able to substitute for practically all the conventional methods of quantitative organic analysis equivalent micromethods requiring only 3 to 5 mg. of substance and involving substantial savings of time and reagents. His work drew considerable interest in the scientific world and ever since then students of all nationalities, some of them renowned investigators, gathered in his laboratory to acquire the special technique and "microchemical asepsis" of manipulation. In this country a number of chemists will remember with gratitude the hours spent in his institute, not only because of the knowledge gained, but also for the contact with an outstanding and original personality of fine human qualities.

O. W.

MEMORIALS

AS a memorial to the late Louis Agassiz Fuertes, who until his death in 1927 was generally recognized as America's foremost painter of birds, the Field Museum of Natural History has published in a limited edition an album of reproductions in colors of thirty-two of his finest pictures of birds and mammals. The paintings selected for this portfolio represent the last work of the artist, having been made in Africa while he was a member of the Chicago *Daily News* Field Museum Abyssinian Expedition of 1926–27. Mr. Fuertes was killed in an automobile accident shortly after his return to this country from that expedition. The originals of the paintings were purchased and presented to Field Museum by C. Suydam Cutting, of New York, who was also a member of the expedition. Mr. Cutting in addition paid the cost of the publication of the memorial album. The portfolio is of large size, the plates being eight by ten inches with a ten-inch margin. The album has a preface about Fuertes, the man and his work, written by Dr. Wilfred H. Osgood, the museum's curator of zoology, who was leader of the Abyssinian expedition.

WE learn from the *Journal* of the American Medical Association that the memory of Professor Laveran, who discovered the hematozoon of malaria, and to whom a monument was unveiled last spring at Constantine during the ceremonies commemorating the centenary of the conquest of Algeria, has again been honored at Paris by commemorative ceremonies held at the military hospital of the Ecole du Val-de-Grâce, where he was professor until he reached the army age for retirement, after which he was director of a laboratory at the Institut Pasteur until his death. The ceremonies were held in the great hall of the school. Dr. Roux, director of the Institut Pasteur, presided. Professor Sieur, president of the alumni association of the Ecole de santé militaire du Val-de-Grâce, expressed the thanks of the association to those who had subscribed to the monument. Mr. Calmette gave an account of the life of Laveran and of his discovery. Addresses were delivered by Troussaint, a former coworker of Laveran; by Marchoux, and by Rouvillois, the director of the school. An historical niche was established in the school, in which a glass case encloses the microscope and the observation records of Laveran. Then the audience proceeded to a spot in front of the entrance to the school, which will bear henceforth the name of "Place du docteur Laveran." A commemorative tablet was affixed to the house in which Laveran lived.

RECENT DEATHS

BERNARD BARHAM WOODWARD, librarian and bibliographer at the British Museum of Natural History until his retirement in 1920, died on November 17 at

the age of seventy-seven years. We learn from the London *Times* that his interest in natural history was not confined to librarianship, for he conducted a number of researches on the borderline between zoology and geology, a subject in which his uncle, the late Dr. Henry Woodward, formerly keeper of geology in the British Museum, and his brother, the late Mr. H. B. Woodward, of the Geological Survey, both achieved distinction.

AN Associated Press dispatch reports that Dr. Werner Borchardt, of the Hamburg Tropical Institute, is believed to have lost his life while making observations of an eruption of the Volcano Merapi in Sumatra. Dr. Borchardt was about thirty years old and had been loaned by the Hamburg Institute for a year to the Sumatra Institute to carry out research work on the influence of temperature on the blood and kindred subjects.

SCIENTIFIC EVENTS

THE BRITISH ASSOCIATION OF SCIENTIFIC WORKERS

THE Association of Scientific Workers, according to a note in *Nature*, in spite of the financial stringency with which it, like other good causes, is afflicted, still adds to its record of achievement. During the past few months it has prepared, and submitted to the Royal Commission on the Civil Service, a formidable body of evidence dealing with the position of the scientific civil servant *vis-à-vis* his administrative colleague, and advocating the unification of all the state scientific services under a Ministry of Science. At the same time, the association has prepared an index of references to science and cognate matters in the parliamentary debates, and through its general secretary, Major A. G. Church, M.P., has formed a parliamentary science committee. This committee, consisting of members of both houses and all parties, meets periodically to hear the views of acknowledged experts on scientific questions which bear on public affairs.

Some years ago the association issued an appeal for members, in the form of a letter signed by some of the most prominent men of science in Great Britain. This letter was sent to about 20,000 scientific workers, and resulted in a large increase of membership. At the present time the association is sending out another such appeal, on a much more elaborate scale. It consists of a sixteen-page booklet entitled "The Profession of Science," containing articles by Sir Richard Gregory, Professor Julian Huxley, and others, with messages from Sir Ernest Rutherford, Sir William Bragg, the Right Honorable W. G. A. Ormsby-Gore and Professor F. G. Donnan, and a preface by Sir Daniel Hall as president of the association. The booklet is being sent to 25,000 scientific workers, and at the same time a card index of qualified scientific men is being prepared, with the intention of preserving it and keeping it continually up-to-date. In this way, as a by-product of the association's own propagandist activities, information is being collected which will prove invaluable when it becomes possible to create an authoritative register of the profession of science, such as the professions of law, medicine, dental surgery and teaching already possess. Work on this card index has been in progress for four weeks, and it is already clear that the figure of 25,000 falls considerably short of the total of qualified workers in Great Britain.

BIRD SANCTUARIES

PURCHASE of land for migratory game-bird refuges in four states was authorized on December 18 by the Migratory Bird Conservation Commission.

The four proposed refuges had been surveyed previously by biologists and land valuation experts of the Biological Survey, and the Department of Agriculture had approved their acquisition as units in the nation-wide system of refuges authorized by the Congress.

The new Florida refuge will extend about 12 miles along Apalachee Bay, in Wakulla, Jefferson and Taylor counties, and will be known as the St. Marks Migratory Bird Refuge. It will contain 13,981 acres.

The new purchases in California will add 8,982 acres to the Salton Sea Wild Life Refuge, created by Executive Order of November 25, 1930. The purchase authorized, together with the public lands recently set aside by the President, will create a refuge of more than 24,715 acres for waterfowl and other migrants in the Imperial Valley.

The Swanquarter Migratory Bird Refuge will be established in North Carolina under the new authorization. This will consist of 11,778 acres in Hyde County, on Pamlico Sound, and together with intermingled areas of water will make an administrative unit of about 20,000 acres.

In the sandhills of western Nebraska the purchase of 39,038 acres is authorized for the establishment of a migratory bird refuge in an area resorted to by great numbers of waterfowl in the nesting season. This is in Garden County and will be known as the Crescent Lake Migratory Bird Refuge.

The Migratory Bird Conservation Commission, which was created by the act providing for a ten-year

program of refuge acquisition consists of Secretary Hyde, of the Department of Agriculture; Secretary Lamont, of the Department of Commerce; Secretary Wilbur, of the Department of the Interior; Senator Norbeck, of South Dakota; Senator Hawes, of Missouri; Representative Ackerman, of New Jersey, and Representative McReynolds, of Tennessee. Rudolph Dieffenbach, in charge of land acquisitions of the Bureau of Biological Survey, is secretary of the commission.

The new purchases authorized, together with those previously approved by the commission, and those established by executive orders since the inception on July 1, 1929, of work under the Migratory Bird Conservation Act, make a total of 158,167 acres that will become inviolate sanctuaries for the conservation of migratory birds.

The ultimate objective is the establishment of one or more such refuges in each state of the union. The act authorizes annual appropriations for ten years for the purpose of carrying out this objective.

DEDICATION OF McGREGORY HALL OF CHEMISTRY AT COLGATE UNIVERSITY

BLESSED with about as fine weather as the Chenango Valley can afford at this time of the year, the formal dedication of McGregory Hall of Chemistry at Colgate University, Hamilton, N. Y., took place on December 5 and 6, 1930. Delegates from thirty-four colleges, universities and scientific societies spent the best part of two days as guests of the university.

The formal program began Friday at 2:00, following the traditional academic procession to McGregory Hall, when President George Barton Cutten paid a tribute to the memory of Miss Evelyn Colgate, who provided by the terms of her will the original funds toward the erection of the laboratory. To this sum, her parents, Dr. and Mrs. James C. Colgate, of New York, added the funds necessary to complete and equip the structure. Dr. Cutten also paid a tribute to Professor Joseph Frank McGregory, in whose honor the laboratory is named. Dr. McGregory was the first professor of chemistry at Colgate and for forty-five years has directed the destiny of the department.

The first speaker on the program was Dean Edward Ellery, an alumnus of Colgate, a former member of the teaching staff and now dean of the faculty of Union College. In a brilliant address Dr. Ellery gave a historical account of "Chemistry at Colgate," with many interesting references to his former teacher.

The address of dedication was then given by President Livingston Farrand, of Cornell University. Dr. Farrand stressed the necessity of cooperation between the sciences, giving many examples from his rich experiences as a physician and university administrator.

With the singing of the Alma Mater, the delegates and friends were taken on a tour of inspection of the laboratory, ending in the museum where tea was served by the ladies of the chemistry staff.

At 6:30 P. M. a "speechless" dedication dinner was served at Colgate Inn for the delegates, university trustees and other invited guests. Following the dinner, everybody came back to McGregory Hall for a public address by Dr. Harrison E. Howe on "Chemistry Remaking the World." Dr. Howe made use of his familiar black bag and really astounded his audience by his collection of products of the chemist's art. Dr. Howe was introduced by his friend of many years, Dr. J. F. McGregory.

Saturday morning Alpha Nu Chapter of Alpha Chi Sigma at Colgate was host at a breakfast at the College Commons. The rest of the morning was spent in a conference on chemical education, at which Dr. R. C. Roberts, head of the department, presided. Dr. Neil E. Gordon gave the first address on "Chemical Education for Teaching and Research." He told of the origin of the Division of Chemical Education and made a strong plea for cooperation between chemists as well as other scientists in developing educational methods and courses in chemistry. He also gave an intimate view of the work being done at the Johns Hopkins University in the selection and training of men for chemistry.

"Chemical Education for Medicine" was ably handled by Dr. Walter R. Bloor, associate dean of the school of medicine and dentistry of the University of Rochester. Dr. Bloor indicated the difficulties and intricacies of medical training and the demand for sound training in chemistry for the prospective medical student.

The closing address of the conference and the dedication program was given by Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research, on "Chemical Education for Industry." Dr. Weidlein pointed out the qualifications necessary for a successful career in industrial chemistry, giving intimate experiences in this connection at the institute. He stressed the importance of better training in chemistry, a knowledge of economics, the ability to use the English language, a personality that gets along with people and last of all the necessity of hard, painstaking work.

R. C. ROBERTS

POPULAR SCIENCE MONTHLY AWARD

DR. GEORGE H. WHIPPLE, dean and professor of pathology of the School of Medicine and Dentistry at the University of Rochester, and Dr. George R. Minot, professor of medicine in the Harvard Medical School, discoverers of the value of liver and liver extract as a treatment for pernicious anemia, formerly incurable, received on December 18 at a dinner at the University Club, New York, a $10,000 prize offered by *The Popular Science Monthly* for "the current achievement in science of greatest benefit to the public." The awards and gold medals were presented by Dr. Robert A. Millikan, chairman of the executive council of the California Institute of Technology, and responses were made by Dr. Minot and Dr. Whipple. Addresses were then made by Dr. Simon Flexner, director of the Laboratories of the Rockefeller Institute for Medical Research, and by Dr. Millikan. According to a press report Dr. Millikan said:

Only that is of most potential value to the human race which represents a fundamental increase in human knowledge not only in one way but in many ways. Every bit of our material civilization to-day can be traced to the discarding by Galileo and Newton of the a priori method of approaching reality and substituting for it the method of empiric investigation.

Until twelve years ago we lagged far behind other nations of the world in fundamental science. That was inevitable as long as we focused our attention on the immediate application of science to some practical end. The foundation of the national research fellowships has put this country far ahead of what it was. Within the last twelve years our physics in the United States has leaped forward more than it had ever done in any previous decade.

The first thing is to see that the spirit of science should be kept strong and active. The second is to spread the gospel of science throughout the country. Our work to succeed must be brought before the attention of the intelligent public in order that it might have a universal appeal. If it does not have a universal appeal, it will eventually fail.

Dr. Millikan cited the Nobel prizes as an example of bringing the work of scientific research before the general public. *The Popular Science Monthly* awards, he declared, were in the same category with the Nobel prizes in that they will spread knowledge of what is being done in laboratories among the public and will add stimulus to research in pure science.

The committee of award consisted of:

Dr. Frank B. Jewett, vice-president, American Telephone and Telegraph Company, *chairman*.

Dr. C. G. Abbot, secretary, The Smithsonian Institution.

Dr. Samuel A. Brown, dean, New York University and Bellevue Hospital Medical College.

Dr. George K. Burgess, director, U. S. Bureau of Standards.

Dr. William W. Campbell, president emeritus, University of California; director emeritus, Lick Observatory.

Dr. Harvey N. Davis, president, Stevens Institute of Technology.

Dr. Arthur L. Day, director, Geophysical Laboratory, Carnegie Institution of Washington.

Dr. E. E. Free, consulting engineer.

Dr. Vernon Kellogg, permanent secretary, National Research Council.

Charles F. Kettering, president and general director, Research Laboratories, General Motors Corporation.

Dr. Arthur D. Little, president, Arthur D. Little, Inc., Chemists.

Dean Collins P. Bliss, director, Popular Science Institute, New York.

Dr. John C. Merriam, president, Carnegie Institution of Washington.

Dr. Robert A. Millikan, chairman, executive council, California Institute of Technology.

Professor Henry Fairfield Osborn, president, The American Museum of Natural History.

Dr. S. W. Stratton, Massachusetts Institute of Technology.

Dr. Elihu Thomson, director, General Electric Research Laboratories (Lynn, Massachusetts).

Dr. Edward R. Weidlein, director, Mellon Institute of Industrial Research.

Henry H. Westinghouse, director, Westinghouse Electric and Manufacturing Company.

Dr. Albert E. White, director, department of engineering research, University of Michigan.

Dr. Willis R. Whitney, vice-president and director of research, General Electric Company.

Orville Wright, scientist and inventor.

SCIENTIFIC NOTES AND NEWS

THE American Association for the Advancement of Science and about forty associated societies will meet at Cleveland during the week beginning December 29. The number of SCIENCE for November 28 was a special issue containing the preliminary announcement of the meeting edited by the permanent secretary. Dr. Thomas Hunt Morgan will preside at the opening session, when Dr. Robert A. Millikan will give the address of the retiring president on "Atomic Disintegration and Atomic Synthesis."

DR. ALBERT A. MICHELSON completed his seventy-eighth year on December 19, while engaged at Pasadena on the measurement of the velocity of light through a vacuum tube.

DR. JAMES H. BREASTED, of the University of Chicago, director of the Oriental Institute, has been

elected a corresponding member of the Institute of France. He succeeds to the place occupied by the late Sir Edward Maunde Thompson, for many years director of the British Museum.

DR. HEINRICH JACOB GOLDSCHMIDT, professor of chemistry at Göttingen, formerly of Oslo, has been elected a member of the Göttingen Academy of Sciences.

DR. PHILIPP FURTWÄNGLER, professor of mathematics at the University of Vienna, has been awarded the Ernst Albe memorial prize and medal of the Carl Zeiss Foundation.

THE gold Georg-Neumayer Medal of the Geographical Society of Berlin has been conferred on Dr. Hugo Eckener.

DR. CLAUDIUS REGAUD, director of the Radium Institute and professor at the Pasteur Institute of Paris, has been created commander of the Legion of Honor.

A JOHN C. HEMMETER professorship of physiology will be established at the University of Maryland School of Medicine, in honor of Dr. Hemmeter, who was graduated from the University of Maryland in 1884, and was appointed professor of physiology in 1891 and of clinical medicine in 1903. He resigned in 1922. Besides Dr. J. M. H. Rowland, dean of the school, the committee includes Dr. John Evans, secretary, and Drs. William J. Mayo, Julius Friedenwald, Randolph Winslow, J. M. T. Finney, Harry Adler, Robert P. Bay, William H. Smith, Thomas S. Cullen, H. A. B. Dunning, Arthur M. Shipley and Judge Walter I. Dawkins.

AT the annual meeting of the New York Academy of Sciences on December 15 the A. Cressy Morrison Prizes for 1930 were awarded to Professor H. von Zeipel, of the Astronomical Observatory at Upsala, for his paper entitled "The Evolution and Constitution of Stars"; to Dr. Ernst Gellhorn, of the University of Oregon, for his paper entitled "Permeability and Fatigue in Muscle and its Bearing on the Problem of Ion Antagonism," and to Dr. Douglas W. Johnson, professor of physiography at Columbia University, for his paper entitled "A Theory of Appalachian Evolution."

OFFICERS of the New York Academy of Sciences have been elected as follows: *President,* Clark Wissler; *Vice-presidents,* Horace N. Coryell, Horace W. Stunkard, Frederick W. Hodge; *Recording Secretary,* Roy Waldo Miner; *Corresponding Secretary,* Horace W. Stunkard; *Treasurer,* George H. Sherwood.

DR. CARL GUTHE, director of the Museum of Anthropology at the University of Michigan, was reelected president of the Michigan-Indiana Museum Association at the convention held recently at South Bend, Indiana.

DR. GEORGE D. LOUDERBACK, professor of geology, chairman of the department, and dean of the College of Letters and Sciences of the University of California, has been reelected president of the American Seismological Society. Dr. Perry Byerly, assistant professor of seismology and university seismologist, has been elected secretary.

DR. NEIL E. STEVENS, of the Bureau of Plant Industry, has been elected president of the Botanical Society of Washington.

DR. JUAN CARLOS NAVARRO, pediatrist, has been elected president of the Academy of Medicine of Buenos Aires.

AT the annual meeting of the Royal Society of Edinburgh Sir E. A. Sharpey-Schafer was elected president. The vice-presidents elected were Professor J. Graham Kerr, Professor W. Wright Smith, Professor F. G. Baily, Professor T. J. Jehu, Professor J. H. Ashworth and Dr. A. Logan Turner.

MR. W. L. GOSS, who has been connected with the Bureau of Plant Industry since 1905, has accepted an appointment with the California State Department of Agriculture. Mr. Goss will be in charge of the seed work for the state, including direction of the cooperative seed laboratory at Sacramento.

MR. CHARLES H. HADLEY, of the Bureau of Entomology, has been appointed to take charge of research on the Japanese beetle and Asiatic beetle at Moorestown, New Jersey. Mr. Hadley succeeds Loren B. Smith who resigned recently and comes to the bureau by transfer from the Plant Quarantine and Control Administration. Mr. L. H. Worthley, administrator in the field in the enforcement of the quarantine on account of the European corn borer, has taken over the field work of administering the Japanese beetle quarantine, of which Mr. Hadley has been in charge for two and a half years.

PROFESSOR VICTOR K. LAMER, of the department of chemistry, Columbia University, who is on sabbatical leave from the university where he has taught since 1919, will be visiting professor at Stanford University during the spring session of 1931. He will direct courses in physical chemistry and catalysis. Professor LaMer is a former chairman of the Organic Division of the American Chemical Society.

DR. EDMUND S. CONKLIN, professor of psychology in the University of Oregon, has been granted leave of absence for the winter term of the present academic year, and has accepted a visiting professorship in the University of Chicago for that period.

DR. E. LEG. TROUGHTON, of the Australian Museum, Sydney, is visiting the United States.

MR. C. P. CLAUSEN, of the Bureau of Entomology, who returned from Singapore to the United States late in September, left Washington on November 20 for Cuba, where he will observe the progress of the experimental work on the infestation of black flies with the parasites he brought over from the Malay Peninsula. Mr. Clausen will take some of the black flies from Cuba to Singapore, infest them with parasites, and send them back to Cuba.

DR. LAFAYETTE B. MENDEL, Sterling professor of physiological chemistry in Yale University, gave an illustrated lecture at Wellesley College on December 3, and before the Rhode Island Section of the American Chemical Association at Providence on December 11 on "Fat Formation in Relation to Diet."

DR. GEORGE E. NICHOLS, professor of botany at Yale University, delivered an illustrated lecture entitled "North American Arctic-Alpine Plants" at the Science Club of the Connecticut College for Women on December 12.

DR. M. H. SOULE, associate professor of bacteriology at the University of Michigan Medical School, gave an address on the first International Congress of Microbiology, held at the Pasteur Institute, Paris, from July 20 to 25, before the Biological Society of Purdue University on December 11. Dr. Soule was a member of the national committe of the congress.

ON November 24, 1930, Dr. Michel Weinberg, professor of bacteriology and chief of the laboratory service of the Pasteur Institute, Paris, gave an illustrated lecture before the faculty and students of the University of Colorado School of Medicine at Denver on "The Rôle of the Anaerobic Bacteria in Human Pathology." On November 25, Dr. Weinberg lectured before the Denver City and County Medical Society on "The Serotherapy of Medical and Surgical Infections Caused by Anaerobic Bacteria."

DR. W. STEWART DUKE-ELDER, of London, gave two lectures under the auspices of the Howe Laboratory of Ophthalmology on "Recent Work on the Metabolism of the Eye" at the Harvard Medical School on December 15 and 17. The first lecture was entitled "Physiological Aspects" and the second "Clinical Aspects."

RECENT speakers before the Geological Society of Northwestern University, with the titles of their addresses, are: Dr. G. R. Mansfield, U. S. Geological Survey, "New Discoveries in Geologic Structure"; Dr. David White, U. S. National Museum and Geological Survey, "Stratigraphic Problems of the Permo-Carboniferous"; Dr. Margaret Fuller Boos, U. S. National Park Service, "Geology of the Bryce Canyon Region"; Mr. Earl A. Trager, Skelly Oil Corp., "Subsurface Correlation in the Mid-Continent Field"; Dr. G. F. Loughlin, U. S. Geological Survey, "What is an Economic Geologist?"; Dr. Douglas W. Johnson, Columbia University, "Significance of the Low Shore Terraces"; Mr. King Hubbert, University of Chicago and Columbia University, "Isostasy."

THE North Jersey Section of the American Chemical Society will meet at the Hotel Winfield Scott, Elizabeth, New Jersey, at 7:45 p. m., on Monday, January 12. Dr. Saul Dushman will address the section on "The New Mechanics in Relation to Chemistry." An informal dinner at 6:30 p. m. will precede the meeting.

THE Committee on Scientific Research of the American Medical Association invites applications for grants of money to aid in research on problems bearing more or less directly on clinical medicine. Preference is given to requests for moderate amounts to meet specific needs. For application forms, please address the committee at 535 North Dearborn Street, Chicago, Illinois.

A NEW laboratory of the Rockefeller Institute for Medical Research is ready for occupancy this month. It stands on a high, stony bluff overlooking the East River and extends from 67th to 68th Streets. The building is seven stories in height with two basement levels, and has a cubage of about 1,500,000 feet. Connected with the laboratory is a wing of four stories for animals, which in turn connects through an additional new low animal unit of four stories with the main animal house which is six stories in height.

BUILDING will be started on the Benjamin Franklin Memorial and Franklin Institute Museum at Philadelphia in a few weeks, according to an announcement made by Mr. Cyrus H. K. Curtis, president of the Benjamin Franklin Memorial, Inc., who was host at a dinner given recently to 2,200 people who took part in the campaign to raise funds for the institution. John T. Windrim is preparing the plans. Subscriptions amounted to $5,060,809, in addition to $2,500,000 provided by the Franklin Institute for endowment. The central exhibition hall of the new building will be named the "Cyrus Herman Kotzschmar Curtis Hall" and the scientific library will be named in honor of former Senator George Wharton Pepper, chairman of the financial campaign.

A BEQUEST of $100,000 is made to Western Reserve University in the will of the late Dr. George Clark Russell.

A RHODODENDRON collection, said to be the finest in the United States, has been presented to the Univer-

sity of California by a group of donors. The collection contains 10,000 specimens, more than half of which are of especial interest. The collection was purchased from Messrs. Carl H. Andries and M. Jongeneel, who had propagated the plants at their nursery at Aptos, near Santa Cruz. Mr. Andries has been appointed superintendent of the Botanical Garden and rhododendron expert.

The Mexican scientific society "Antonio Alzate" (founded in 1884) by virtue of a resolution passed by the President of the Republic and the Department of Public Instruction has been constituted as the National Academy of Sciences, under the title of Academia Nacional de Ciencias Antonio Alzate and was inaugurated on December 9. Its offices and library have been established in the new building that the Federal Government has granted to it at Justo Sierra Street, No. 19. The president of the academy is Alberto Maria Carreño, and the permanent secretary Rafael Aguilar y Santillan.

Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research, has announced that the institution has lately begun a broad investigation into possible industrial uses for raw and refined sugar. The research will be carried on by a multiple industrial fellowship that will be sustained by The Sugar Institute, Inc., of New York, an organization that represents the cane sugar refiners of the United States. The comprehensive program of investigation will be supervised by Dr. George D. Beal, assistant director of the Mellon Institute, and by Dr. Gerald J. Cox, senior industrial fellow. They and the scientific investigators who will be under their direction in endeavoring to find and to develop uses for sugar in various industries will have the close advisory collaboration of Dr. Leonard H. Cretcher, the sugar specialist who is the head of the Department of Research in Pure Chemistry. According to Dr. Weidlein, various studies made by private research workers have already indicated results of industrial promise; these findings will be carefully studied in the laboratories of Mellon Institute. Most of these proposals relate to applications for sugar in such technologic practises as wood preservation, textile finishing, and the manufacture of adhesives. Sugar is thought to merit searching investigation as a basic raw material for employment in various branches of chemical industry. Four chemists, headed by Dr. Cox, have begun the initial scientific research of the industrial fellowship. Additions will be made to this staff, as needed, from time to time.

The Official Record of the U. S. Department of Agriculture reports that an investigation which, if successful, will lead to the commercial propagation of certain species of flies to be used by the medical profession in treating wounds and inflamed bones is under way in the Bureau of Entomology. This new treatment is the outgrowth of an accidental discovery by Dr. William S. Baer, clinical professor at the Johns Hopkins University. While serving at the front in the war, Dr. Baer was greatly interested in the remarkable healing of the wounds of two soldiers who had been brought in after lying for seven days on the battle field. The wounds were heavily infested with fly larvae. About eight years later Dr. Baer tried the larval treatment on a few of his patients who were suffering from osteomyelitis. Since then nearly 300 patients have been treated in this way. All the children and four out of five of the adults recovered, the cure usually being effected within six weeks. The success of Dr. Baer's experiments and the large number of cases to which this treatment is adapted have created a demand for larvae. The department entomologists are interested in accurate identification of the flies, in methods for their propagation in large numbers, and in methods of producing enough larvae in suitable condition for the surgeon.

It has been decided that the British Photographic Research Association should go into voluntary liquidation. This decision, according to the London *Times*, has been reached in full accord between the Department of Scientific and Industrial Research and the manufacturer members of the association. Two main factors have necessitated this decision. The first is that important changes have taken place in the organization of the industry itself; manufacturing interests have been consolidated, and as a result the number of separate firms interested in the work of the association has been considerably reduced. The second factor is a very marked increase in the research work carried out in the laboratories of the manufacturing firms themselves. This widening of the outlook of the industry with regard to research is one of the results which it was hoped the research association would achieve. In a statement announcing the dissolution of the association acknowledgment is made of the valuable assistance and encouragement given by the Department of Scientific and Industrial Research, and grateful thanks are given to the director of research, Dr. T. Slater Price, who, assisted by a loyal staff, has throughout his period of office so ably and efficiently served the association.

The registrar-general's statistical review for 1929, recently published, shows, according to a summary in the *Journal* of the American Medical Association, that the estimated population of Great Britain and Ireland was 48,684,000, compared with 48,574,000 in 1928, an increase of 110,000, or 0.23 per cent. Taking the constituent parts of the British Isles

separately, there was an increase in England and Wales and a decrease in Scotland and the Irish Free State. The estimated population of England and Wales in 1929 was 39,607,000, against 39,482,000 in 1928, an increase of 125,000, or 0.32 per cent. For Scotland the figures are 4,884,000 and 4,893,000, a decrease of 9,000, or 0.18 per cent.; for the Irish Free State 2,943,000 and 2,949,000, a decrease of 6,000, or 0.2 per cent. The marriage rate for England and Wales during 1928 was 15.8 per thousand living and was the highest since 1921. The number of divorces was 3,396 against 4,018 in 1928, a decrease of 15.5 per cent. The birth rate was 16.3 per thousand of population, against 16.7 in 1928, thus continuing the steady fall of recent years. The proportion of male to female births was 1,043 to 1,000, a close approximation to that in recent and prewar years.

DISCUSSION

AN INTERNATIONAL BOTANICAL ADDRESS BOOK

AT the final plenary meeting of the Fifth International Botanical Congress, Cambridge, England, August 23, 1930, it was unanimously resolved that an international address book of botanists should be prepared and published. A committee consisting of Professor L. Diels, director of the Botanic Gardens, Berlin-Dahlem, Dr. E. D. Merrill, director of the New York Botanical Garden, and Dr. T. F. Chipp, assistant director of the Royal Botanic Gardens, Kew, England, was appointed to consummate the project.

The last publication of its kind, Dorfler's "Botaniker Addressbuch," was published in 1909; the need of an up-to-date publication has been increasingly felt in late years, with the rapid growth of botanical science and the necessity for more general communication and cooperation among botanists in different parts of the world.

At meetings of the committee held in London on August 25 and September 4, 1930, it was agreed that:

(1) The address book should follow the general scheme of Dorfler, but the countries to be arranged alphabetically with a supplementary index by continents.

(2) The sections under each country should comprise a list of institutions and societies, and a list of botanists, with their surnames and initials, professional qualifications, offices, addresses and the special field of interest of each individual.

(3) Entries should be made in the language of each country in Roman characters.

(4) In applied subjects, such as forestry, agriculture and bacteriology, only those working in the botanical aspects of the subject should be included.

(5) The final compilation of data should be done at Kew.

It was tentatively decided that April 1, 1931, or a later date, if necessary, would be the date for closing the entries.

The committee realized that if the project was to be successfully consummated, the assistance of botanists in each country would be necessary. Accordingly, each member of the committee undertook the responsibility of collecting and collating the necessary data from the various parts of the world. Professor Diels accepted Central and Eastern Europe, U. S. S. R. and most of South America; Dr. Merrill, the whole of North America, the West Indies, other than the British colonies, Colombia, Ecuador, British, French and Dutch Guiana, Venezuela, Paraguay, all of Polynesia, and the Philippines, and Dr. Chipp the rest of the world.

Dorfler's address book had about 12,500 entries. It is estimated that a comprehensive new address book will contain in excess of 20,000 entries. To make it reasonably complete the cooperation of botanists everywhere is desired. If individuals within the areas assigned to me and who desire their names to appear in the new botanical address book will send me a post card giving the data required, I will see that these data are properly compiled and transmitted to the central office at Kew. What is needed in each case is the name and initials of the individual, his or her address, degrees and titles, position and special field of interest. About ninety collaborators have been selected and asked to compile data for specific areas, covering institutions and societies as well as individual names and addresses. Names of many individuals who should appear in the new address book will doubtless be overlooked, hence this appeal to individual botanists everywhere. Please compile the data required on an ordinary post card, in typewriting if possible, and send it to the undersigned; all such supplementary data will be collated with those supplied by the selected collaborators, before transmission to Dr. Chipp at Kew.

E. D. MERRILL

NEW YORK BOTANICAL GARDEN,
BRONX PARK, NEW YORK

THE WHALING SITUATION

DURING the past two years the writer has been interested in collecting statistical matter relative to present-day whaling. In a presentation of this subject in the January, 1930, number of the *Bulletin* of the New York Zoological Society, he introduced sta-

tistics showing the annual world catch as exceeding 20,000 whales. There were no returns then available of later date than 1928.

We are now in possession of statistics on whaling in all parts of the world for the season 1928–1929, showing a catch of 27,566 whales, yielding 1,867,848 barrels of oil. The composition of this catch was: blue whale 13,650, finback 9,132, sperm whale 1,761, sei whale 1,549, humpback 304, other whales 1,170. The species taken in greatest number is the blue whale, constituting nearly half of the total catch. To the above world catch may be added a few gray, beaked, bottle-nosed right and other whales now seldom found. The equipment employed in world whaling during the 1928–29 season was 25 shore stations, 30 floating factories and 237 killing boats attached to stations and factory steamers.

Norwegian whaling in all seas is far in the lead, with a catch of 14,996 whales. British whalers took 8,230 whales. The United States, once leader in the industry, does not figure, as the limited amount of whaling off our west coast and at Alaska shore stations is under Norwegian auspices, as is also that of British Columbia.

Mr. Takahashi, of the Marine Products Company of Tokyo, has supplied certain details respecting whaling in Japanese waters: The gray whale formerly rather common there is now rare, only six having been taken in 1928. Whales being used extensively for human food in Japan, the yield of oil for that country is not included in the above world total of products.

Other countries engaged in whaling in addition to those already mentioned are Denmark and Argentina, with a total of 1,770 whales. Shore whaling stations in South Africa and on islands in the Antarctic are operated by both Norwegian and British companies. At the present time whaling is conducted chiefly in Antarctic waters, where the annual catch of whales is on the increase. The whaling industry in northern waters is declining.

There has been an increase in the number of floating factories operating in the Antarctic, where the fleet is assembling for the Antarctic summer season. It seems probable that with increased equipment the total catch of whales for the 1930–1931 season will exceed that of any season so far recorded.

C. H. Townsend

New York Aquarium,
December 18, 1930

A SEQUOIA FOREST OF TERTIARY AGE ON ST. LAWRENCE ISLAND

The recent discovery of the fossil foliage, cones and wood of Sequoia on St. Lawrence Island, in the Bering Sea, is of exceptional interest from the standpoint of the Tertiary distribution of this genus, and the geographic conditions under which it formerly lived.

Several references in the literature to the occurrence of fossil Sequoia on St. Lawrence Island have not been substantiated up to this time by actual specimens, so far as known to the writer. With the hope of securing material evidence of the occurrence, a request was made last May to Dr. Henry B. Collins, Jr., of the Smithsonian Institution, that he collect any fossil plants encountered during his ethnological investigations there. With the assistance of Captain Edward D. Jones, of the Coast Guard cutter *Northland*, Dr. Collins visited the locality near the west end of the island on August 14, and collected the specimens which are the basis of this record. Writing to me from Nome on August 20, Dr. Collins makes the following statement:

> I have just returned from St. Lawrence Island where I took occasion to look up the fossil plants mentioned in your letter of May 2. From the Eskimos I learned the location of the place they occurred (15 miles east of the N.W. end of the Island), and when the *Northland* came for me we stopped for a few hours and made a collection. Captain Jones was much interested, for which we may both be grateful, for it would have been difficult to reach the place except with the ship. Along a high bank bordering a lake, outcrops of coal were visible, and associated with these, slides of reddish slate in small blocks. These were very rich in fossil plants. Captain Jones is bringing you what I hope will be an adequate sample, almost one hundred pounds of the rock slabs.

When the *Northland* reached Oakland on November 23, Captain Jones turned over this collection to me. It comprises some twenty-five slabs bearing abundant impressions of the leafy twigs of *Sequoia langsdorfii*,[1] with a few Sequoia cones and the impressions of several broad-leafed species. There are also some specimens of fossil wood, all apparently of Sequoia, which indicate that the trees represented were of a size comparable to the living redwood, *Sequoia sempervirens*. The broad-leafed species include a species of poplar, probably *Populus richardsoni*, and what appear to be species of sycamore and alder. In addition to these slabs, all of which are a dense gray shale, Captain Jones brought me a small piece of light-colored volcanic tuff bearing impressions of Sequoia leaves, which was picked up elsewhere on the island by a native. It is lithologically similar to the matrix in which abundant fossil Sequoias have

[1] This species is not readily distinguished from the living redwood, *S. sempervirens*, but is considered as distinct because of its geologic antiquity.

been collected in the John Day Basin and elsewhere in western America. A future search for the source of this specimen may result in the discovery of many other species which are the common Tertiary associates of the Sequoia.

The occurrence of this genus on St. Lawrence Island during the Tertiary is highly significant in the light of its distribution elsewhere in the north Pacific region during that period. It is of wide extent in North America from California and Colorado north to Alaska, and is commonly associated in the fossil record with the Tertiary equivalents of most of the species now living in the Coast Redwood forest and in the Bigtree groves of the Sierra Nevada, in California. In Asia *Sequoia langsdorfii* and many of its American fossil associates are found in Manchuria and Siberia. St. Lawrence Island, at 63½° north latitude, lies approximately 40 miles from the nearest shore of Asia and 100 miles from the Seward Peninsula in North America.

A study of the distribution of the modern redwood along the California Coast indicates that its migration over a salt-water barrier is seldom if ever achieved. There are no known cases of the occurrence of redwoods on the islands adjacent to the main land occupied by the Redwood Belt. This is due partly to the fact that the redwood is largely restricted to valleys protected from the wind, where rich soil and constant climatic conditions are in marked contrast with those of the shore habitat. It is also due to the difficulty of cone distribution; the green cones are so heavy that they do not float; by the time they have dried out and become buoyant, the seeds have been shed. One of the common tests for viability of redwood seeds is to place them in water, the viable seeds sinking. While there is no reason to believe that redwood seeds would lose their viability through exposure to salt water for a few days, it is difficult to reconstruct conditions under which they would be floated either before or after being shed from the cones. The possibility must be considered that a trunk, with a cone-bearing branch attached, might have floated across the 40 miles of water from the mainland of Asia to St. Lawrence Island during the Tertiary, have seeded the island as a result of being dragged up into a valley suitable for the growth of redwood trees, and have made possible subsequently the journey of another cone-bearing log over the 100-mile stretch of water to North America; or that the journey may have been made in the reverse direction. On the basis of probabilities such a means of migration seems much less likely than that St. Lawrence Island represents the remnant of a land bridge which connected Asia with North America—a bridge over which the redwood forest was essentially continuous during at least the first half of the Tertiary, and across which not only land plants but land animals were able to migrate from one continent to another. The similarity of the life, both fossil and living, of the two continents lends much weight to this interpretation of the Tertiary Sequoia forest of St. Lawrence Island.

RALPH W. CHANEY
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THE DESCRIPTION AND FIGURING OF IMPERFECT FOSSILS

IN 1845 the Rev. P. B. Brodie published a wo with many illustrations on the insects of the Mesoz rocks of England. There were no formal descripti of genera or species, but Brodie considered 32 ov species sufficiently well preserved to deserve nam In 1856, without seeing the specimens, Giebel provided names for 67 others, and much later Handlirsch proposed a number of genera and named 22 other Brodie figures. In one case a figure received a generic and specific name, and being inaccurately copied the copy got another generic and specific designation! The general result is that our catalogues of fossil insects are encumbered with numerous names which represent nothing which can be precisely identified. The example cited is only one of many coming down to modern times.

It is undoubtedly true that on occasion new knowledge or more critical judgment may justify the naming of a fossil first left nameless. But on the whole, if the original author does not care to give a name, the chances are that none is desirable. As it is impossible to prevent the naming of such figures or descriptions, it appears desirable to urge paleontologists to refrain from describing or figuring fossils they do not think deserve a name.

I had some correspondence with an eminent paleontologist on this subject and he was unable to support this conclusion. He urged, with reason, that it was often of importance to indicate the presence of a family or genus, though the species could not be determined. But it seems to me that in all such cases it would suffice to state the fact of occurrence without giving details or figures which could be made the basis of a new name.

T. D. A. COCKERELL
UNIVERSITY OF COLORADO

NAMES AND AMBIGUITY

OCCASIONALLY the technique of scientific writing may be improved by lessons from the technique of journalism.

Except in most exceptional circumstances, such as the progressing death list of a disaster, the modern newspaper insists upon the full name and initials of the news personalities whose doings or statements it reports.

In scientific articles, addresses, reviews and reports it is common practice to refer to scientific colleagues by their last name only. This is particularly the case abroad, especially in France. When scientists were few this practice may have been satisfactory, but, with the growing multiplicity of research and its numerous practitioners, a single last name citation is often ambiguous.

It is not yet necessary to follow the practice of the Library of Congress on its catalogue cards and give the date of birth as well as the full name, but even that practice in some cases would improve our historical horizon.

WATSON DAVIS

SCIENCE SERVICE

SPECIAL CORRESPONDENCE

COOPERATIVE GEOLOGIC RESEARCH NEAR RED LODGE, MONTANA

RESULTS of large scientific interest and possibly of considerable practical importance have been yielded by the work of the geological investigators who operated during the past summer in the region near Red Lodge, Montana--that is to say, along the northeastern border of the Yellowstone Park or Beartooth plateau. Announcement has already been made of the discovery by Professor Edward Sampson, of Princeton, of the similarity in origin of the chromite deposits of the Beartooth area to those of South Africa—heretofore believed to be unique, and also of the finding near Red Lodge of dinosaur egg fragments by Dr. G. L. Jepsen and E. J. Moles, of the Princeton Scott Fund Expedition. These fossils are the first of their kind obtained in North America, and rendered doubly interesting because of recent paleontological prominence given to this region by the discovery of many primitive mammals by Dr. J. C. F. Siegfriedt. A tooth of one of these mammals was pictured and described in the *Literary Digest* as possibly belonging to the oldest known form in man's ancestral line.

An informal preliminary report on the party's study of the great fracture systems in the earth's crust limiting the eastern border of the Yellowstone-Beartooth plateau has been made by Dr. E. L. Perry, of Williams College, and Professor Erling Dorf, of Princeton, has also presented a similar statement regarding the very perfect fossil floras which had been located by Dr. Siegfriedt in beds just below those yielding mammal remains at the Eagle Coal Mine.

The problems of the physical geography and physiography of the region—already partially studied by Dr. Arthur Bevan (now state geologist of Virginia) and by Dr. W. C. Alden, of the U. S. Geological Survey—were further studied last summer by Professor Nevin M. Fenneman, head of the department of geology and geography of the University of Cincinnati and formerly chairman of the division of geology and geography of the National Research Council, and a report is being prepared by Professor Fenneman covering his findings. A detailed map of the river-terrace system around Red Lodge has also been prepared by J. H. Breasted, Jr., a Princeton undergraduate. Reports covering special phases of the chromite deposits are being worked on by E. B. Cartmell, of Yale, and by J. S. Vhay and J. W. Peoples, of Princeton, and the volcanic and intrusive rocks of an area near the Valley Ranch southwest of Cody, Wyoming, are also being studied by J. T. Rouse.

The splendidly exposed sections of marine Cambrian strata now exposed along the mountain uplift were examined during the summer by Dr. C. E. Resser, of the U. S. National Museum, and by Dr. Endo, of Manchuria—Dr. Resser's work being in continuation of his comprehensive studies of the Cambrian of the west which he began as assistant to Dr. Charles D. Walcott, late secretary of the Smithsonian Institution. Professor Dorf and Gordon K. Bell, Jr., of Columbia University, also made a reconnaissance study of the Cambrian, Ordovician and Devonian beds exposed in Beartooth Butte on top of the plateau, and 8,000 feet of Cretaceous-Eocene sandstone and shale beds exposed between the Dry Creek oil and gas field and the Bear Creek coal mines and fossil mammal locality were measured by W. C. Keith, Jr., and G. B. Hulett, of Princeton, as a basis for structural work and as a background for paleontologic interpretations.

Cooperative relations in support of effective, scientific research—both within and without the State of Montana—have been most gratifying and cordial. The Northern Pacific Railway has cooperated most helpfully. Governor J. T. Erickson, of Montana, tendered the assistance of his administration to the party; the officials of the state university, school of mines and Eastern Montana Normal School joined in

planning the work, and the Montana Association, the Billings Commercial Club and the research committee specially appointed by Red Lodge are aiding in arranging for future work. Through Dr. Francis A. Thomson, director of the Montana Bureau of Mines and Geology, the cooperation of the U. S. Geological Survey and the U. S. Army has been secured, respectively, for the topographic mapping and airplane photography of the region to be studied, and the U. S. Coast and Geodetic Survey has promised to extend its chain of gravity stations eastward from Yellowstone Park across this newly mapped area in order to ascertain how the geological and geophysical evidence indicative of the origin of mountain uplift may be harmonized.

Inquiries have been received from Wyoming sources as to the possibility of the work being extended southward into the Cody territory, and this possibility is under consideration at the present time.

W. T. THOM, JR.
RICHARD M. FIELD

PRINCETON UNIVERSITY

SCIENTIFIC BOOKS

A History of Science and its Relations with Philosophy and Religion. By WILLIAM CECIL DAMPIER DAMPIER-WHETHAM. Cambridge, at the University Press. xxii + 514 pp., 14 figs. in text. 1929. Price 18*s*.

To survey the universe from the electron and the cosmic ray to the gene and conditioned reflexes is an intellectual labor truly Herculean in its order of magnitude. But to trace, coordinate and place in their most significant relations man's ever-changing and his so recently greatly enlarged concepts of nature and the discoveries from which they have sprung is a task for which no ancient galaxy of gods has an appropriate prototype. It is Einsteinian in its proportions. The author of this "History of Science" has attempted this survey and analysis, chiefly, he tells us, for his own satisfaction and amusement, but certainly for the intellectual orientation of all who seek in the past an interpretation of this our own era of achievement and of change.

This is more than a history of the sciences or of science. Its central theme seems to be man's continuing efforts to understand and interpret nature and the interaction of his concepts thus derived with philosophy and religion

> Till out of chaos comes in sight
>   Clear fragments of a Whole;
> Man learning Nature's ways aright,
>   Obeying, can control.

To our historian science is more than natural science. It is the ordered knowledge of natural phenomena and also the rational study of the relations between the concepts in which those phenomena are expressed. Philosophy may protest the encroachment.

The work falls into ten chapters. The first four proceed chronologically through the science of the ancient world, the Middle Ages, the Renaissance and the Newtonian Epoch. Thenceforward the treatment separates the physical from the biological sciences, and segregates the interrelation of science and philosophy. Chapters V and IX treat of nineteenth century physics and the new era in physics, respectively. Chapters VI and VIII are concerned with nineteenth century biology and recent development in biology and anthropology. Chapters VII and X give the syntheses of nineteenth century science and philosophy and scientific philosophy and its outlook.

This is no place to construe the argument, much less to criticize the selection or the treatment of the material; both have the horizon and the *élan* to be expected from a scion of the illustrious explorer. The style is lucid, forceful and vigorous. The treatment is comprehensive, judicious and eminently free from bias. The aim is clearly synthetic throughout, and to this end the presentation of the separate scientific fields and of biographical aspects is quite subordinated.

Priority in formulation of an idea or in discovery does not seriously embarrass our historian. "In science 'being right is no excuse whatever for holding an opinion which has not been based on an adequate consideration of the facts involved in it.'"

Noteworthy in this survey is the selection and treatment of significant figures in the onward march of ideas: to alphabetize a few, Aquinas, Aristotle, Francis and Roger Bacon, Bateson, Bergson, Bishop Berkeley, Bernard, Berzelius, Bohr, Boltzmann, Boyle, Burt, Copernicus, Crookes, Darwin, Democritus, Eddington, Einstein, Foster, Galen, Galileo, Gauss, Haeckel, Helmholtz, Van't Hoff, Hume, Huxley, Huygens, Jeans, Kant, Kelvin, Kepler, Laplace, Lavoisier, Leibnitz, Leonardo da Vinci, Liebig, Lucretius, Lyell, Maxwell, Mendel, Mill, Millikan, Newton, Pasteur, Plato, Russell, B., Rutherford, Sarton, Singer, Thomson, J. J., Thomson, W., Voltaire, de Vries and Whitehead.

In a treatise of the scope of this work some deflections of emphasis and preference in selection result inevitably from propinquity and limitations in con-

tact. One has a feeling that the group is a little firmer in the physical than in the biological sciences. In the latter the outlook is quite Batesonian. The historical perspective might well have included L. Agassiz, and more emphasis given to the work of Franklin and Willard Gibbs. One looks in vain for Kircher, the reputed discoverer of bacteria. But one volume can not be an encyclopedia.

This "History of Science" is in sharp contrast with the work of professional historians who weave their interpretations out of the impermanent threads of war, politics or economics. It is an intellectual challenge, though by no means written as such, to all other interpretations of the past, and a most convincing and stimulating revelation of the foundations of this age of material and intellectual achievement.

It should be read and reread by those responsible for the formulation and conduct of all forward-looking educational policies in our universities. It may be illuminating to those advocates of culture who have regarded science as mere technique, and to pietists who fear its materialistic devastations.

CHARLES A. KOFOID
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Comets. By CHARLES P. OLIVIER. The Williams and Wilkins Company, Baltimore, 1930, pp. 246, illustrated. Price $3.50.

PROFESSOR OLIVIER wrote this book as a sequel to his "Meteors" with the purpose of supplying "a book of moderate size . . . useful to the astronomer who does not specialize in the subject, as well as to the average intelligent reader."

There is no doubt that the author succeeded in this. The book is well written and well printed. It fills a gap in modern astronomical literature, especially so as Chambers' "The Story of the Comets" is now somewhat obsolete.

The author selected several topics for his book. After chapters on the history of comets and general facts about comets follows a discussion of cometary groups, families, tails and spectra, chapters on several individual comets, connection of comets and meteors, collision of comets with the Earth and the origin of comets. In the last chapter the author gives his views on the origin of comets, and the appendix contains elementary notions from the theory of orbits.

The desire to avoid mathematics is probably responsible for the absence of a discussion of such important questions as the motion of matter in the heads and in the tails of comets, radiation pressure of the Sun and the luminosity of comets. However, no serious study of comets can avoid these topics, and the author frequently uses the terminology of the theory of comets without explaining it. The result is that in some few places the book will be hardly understandable even to an "intelligent reader." In the chapter on the "Spectra of Comets," for instance, such arbitrary notation as CNIV (cyanogen band λ3883), or the "third negative group of carbon" is mentioned without an explanation. Fluorescence and resonance phenomena are referred to, but the exact meaning of both is left for the reader to find out.

Some inaccuracies are unfortunately present in this book. On page 80 the wave-lengths of the Swan bands are given $\lambda\lambda$5630, 5166, 4719 instead of the correct values $\lambda\lambda$5635, 5165, 4737 for the brightest heads. The author does not explain that the angstrom is used here as the unit. On page 184 the wave-lengths of a band are given "from λ620 to λ700," again without mentioning that $\mu\mu$ is the unit. Indeed, no effort was apparently made to reduce all data to the same units. On many pages miles and kilometers are side by side. Some comets are denoted by Roman numerals according to the time of their perihelion passage; others by letters, according to the order of their discovery.

A misstatement occurs on page 184. The author says about Comet 1910a, "The several preliminary orbits published differed widely from one another. As an example the first three gave the inclination 62°, 85° and 57°, respectively. A correct orbit finally gave it as 139°, entirely reversing even the direction of motion! . . . No decided deviation from a parabola could be found." The reader might possibly infer that something went wrong with the computations, or that the comet was not observed accurately enough. However, this was the classical case of a triple solution, and the definitive orbit by Simas gave an indication of ellipticity.

On page 42, referring apparently to one of the famous "Schmidt's Clouds" in Comet 1882 II, the author says, "Its orbit proved to be quite similar to that of the main comet." On the contrary, Bredichin and others showed that the clouds moved under appreciable repulsive force of the Sun. The comet itself is denoted by the author as 1882 III, instead of 1882 II.

In the appendix the author gives *seven* elements for an ellipse, the semi-major axis and period are listed separately. The latter is denoted for no apparent reason as *Pe.*

From a statement on page 192 the author appears to be unaware that the question of the common origin of comets and asteroids was seriously discussed as early as 1851 by Stephen Alexander.

The typographic work is good, although a few misprints have been noticed. It is unfortunate that

in references the volume is not indicated by the bold-face type as is customary.

The above-mentioned defects are not of a serious kind and can be corrected in the second edition. As it stands, the book will be very useful in awakening interest in comets among amateurs and as a reference book for professional astronomers.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

FIBER TAGS FOR WET SPECIMENS

TAGS bearing catalogue numbers or other entries for the identification of single specimens are an indispensable item in various museum and laboratory collections of objects preserved in fluid. It is obvious that such makeshifts as paper and tape labels are to be avoided, since the first requisite of a tag is permanence. The tag should be made of a durable material which withstands handling and resists disintegration in preserving fluids; the entry which it bears must be permanently clearly legible, and the attachment to the specimen must be secure.

A variety of permanent tags have been devised. Strips of sheet tin, stamped with number dies, may be seen in some zoological collections; these occasionally corrode in preserving fluids. Payne[1] seals a small paper label within a piece of glass tubing, bent into a loop at one end for insertion of the thread for tying. Robertson[2] and Pollock[3] present accounts of the employment of fiber tags in the storage of pathological specimens, at the University of Minnesota and the Mayo Clinic, respectively. Dr. Maude Abbott, in a personal communication, commends the fiber tags, stating that they have been used for some years in the Medical Museum at McGill University. Several years ago the writer, then unaware that the material had been so employed, chanced upon fiber composition for the manufacture of tags. Inquiries indicate that such tags are not generally known, and this note is presented with the aim to emphasize their desirable features. Fiber tags have been used in our laboratory over a period of several years for anatomical specimens preserved in formalin, alcohol, Kaiserling and Bouin's fluid.

Sheets of "vulcanized fiber composition" of different thicknesses and in three colors (red, black and white) are obtainable from dealers in electrical supplies. I have been using the 1/16 inch thickness (red), though a thinner stock may be as serviceable and is perhaps even more suited to tags of small size. The material is sold by weight. A sheet measuring 3 x 3 feet, 1/16 inch thick, retails for about \$2.50. The sheet is cut readily with a paper cutter or heavy shears into tags of the desired dimensions (in this laboratory, about ½ x 1¾ inches). The tags are punched at one end for tying, and stamped with dies (in this laboratory, numbers ¼ inch high) to register the accession number of the specimen. Deep, clean-cut impressions are insured if the tag rests on a block of iron during stamping.

After some hours of immersion in fluid the tag undergoes a just appreciable swelling and becomes slightly limber. Excepting this initial change no alteration can be detected.

The features of the fiber tag may be summarized as follows: (1) permanence and practicability, evidenced by actual service in at least four institutions; (2) simplicity of manufacture; (3) low cost.

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[1] J. F. Payne, "A Permanent Tag for Museum Specimens," Intern. Assoc. Med. Mus., *Bull.* 8, 1922.

[2] H. E. Robertson, "Difficulties Encountered in the Condensation of Museum Material," *ibid.*

[3] M. Pollock, "Methods for Concentration of Museum Specimens," *ibid.*, *Bull.* 10, 1924.

SPECIAL ARTICLES

WESTERN DUCK SICKNESS PRODUCED EXPERIMENTALLY

FOR the past two decades mortality among waterfowl in western states has attracted the serious attention of conservationists. During certain of these years losses among ducks and shore birds have been so great at some points as to make the annual toll taken by hunters appear insignificant. In 1910 untold thousands of waterfowl perished in the marshes about Great Salt Lake, Utah, and the years immediately following saw a recurrence of the sickness but, fortunately, in reduced severity. Yet even under these improved conditions it was necessary to bury the bodies of nearly 50,000 ducks at the mouth of Bear River, Utah, in the period from September 7 to 26, 1913.[1]

In 1914 the Bureau of Biological Survey undertook a study of the malady, assigning Dr. Alexander Wetmore to the task. The summer and fall seasons of 1914, 1915 and 1916 were devoted to the work and the results published in two papers, a preliminary report[2] in 1915 and a final bulletin in 1918[1] (refer-

[1] Alexander Wetmore, "The Duck Sickness in Utah." U. S. Dept. Agri. Bul. 672, pp. 1–26, pls. 4, 1918.

[2] Alexander Wetmore, "Mortality among Waterfowl around Great Salt Lake, Utah," U. S. Dept. Agri. Bul. 217, pp. 1–10, pls. 3, 1915.

ence above). The conclusion reached at that time indicated that the duck sickness in Utah was caused by the toxic action of certain soluble salts found in alkali and pointed to the chlorides of magnesium and calcium as two of the causative agents.

Since 1918 records of the occurrence of duck sickness have shown it to be a wide-spread yet localized malady. Roughly, the range of the disease in the United States conforms to the region of alkaline waters, yet its prevalence by no means coincides with the degree of concentration of alkali. Certain lakes of rather high alkalinity have been found to harbor waterfowl in numbers year after year with no ill effects on the birds, while other waters and marshes of nearly fresh water have experienced outbreaks of great severity precipitated apparently by such factors as low-water level and high temperatures. Under such conditions the attendant phenomenon of profuse decay of vegetable and animal matter often has been reported.

It was, therefore, with the idea of learning whether factors other than alkali might enter into the problem, particularly at points away from the influence of the highly saline conditions at Great Salt Lake, that the Biological Survey resumed its study of this malady. The area chosen was the region of Upper and Lower Klamath Lakes, Oregon, and Tule Lake, California. Preliminary work was started in 1927 when Mr. C. C. Sperry made observations and conducted experiments during August and September. No work was done in 1928, but for the past two seasons the writer has been engaged in this work.

Experiments were conducted along the usual lines of approach. There was feeding of natural and synthetic alkali both by the capsule method and through the medium of drinking water. There were attempts to transmit the disease by the feeding of body tissues of sick birds, and by inoculation in various manners commonly employed in conveying bacterial diseases. The conditions of vegetable and animal decay prevalent in duck sickness areas suggested other experiments and attempts also were made to demonstrate the possibility of certain anaerobic bacteria as a basis of the ailment. All these failed to give anything tangible or consistent in results. Birds were killed in the course of some of the experiments and now and then an isolated or fleeting symptom of duck sickness appeared, but nothing approaching the typical malady was produced or transmitted. Subsequent chemical analyses of waters and muds from sickness and non-sickness areas likewise failed to shed any light on the subject and until the middle of the present summer the whole problem seemed to be in more of a maze than ever.

About that time, however, a clew, revealed by the fortuitous circumstance that I was inadequately prepared to preserve under refrigeration certain body tissues of sick birds that were being fed to gulls in an attempt to transmit the disease, led to a series of experiments giving results wholly unexpected in the light of earlier investigations of duck sickness. Without going into detail at this time, the principal findings may be stated in the following language:

(1) Duck sickness symptoms, including the paralysis or weakness of the wing, leg and neck muscles, the paralysis of the nictitating membrane, discharges from the eyes and nostrils, difficulty in breathing, a lowered body temperature, and green diarrhea, all have been accurately and repeatedly reproduced by the feeding of the incubated body tissues of birds that have died of duck sickness after this material has been kept at a temperature of 85° Fahrenheit for 5 or more days.

(2) Allowing for variations due to the factor of individual susceptibility, the rapidity and severity of the onslaught of symptoms appears to be directly proportional to the quantity of material fed. With mallards and pintails, single doses of from 1/20 to 1/10 gram have permitted the birds to recover within four to six days in some of the cases, while doses as great as 1/2 gram to 1 gram usually have proved fatal within 12 to 24 hours.

(3) The virulence of this toxic material appears greatest when derived from birds that are the same, or are closely related to, the species being treated. Much still remains to be learned by experimentation in this direction, but up to the present time the writer has been unable to produce duck sickness symptoms in gulls by feeding material derived from any species of duck, and, in like manner, material from pintails appears more toxic to individuals of that species than to mallards.

(4) Even under the limitations of a field laboratory, it has been noted that certain batches of "incubated" tissues of birds dying of duck sickness do not become toxic. In such cases the difference in condition often is visible to the unaided eye, as, for instance, when liquefying bacteria become dominant and decomposition follows along a line quite different from that which gives toxic results.

(5) Although most of the results were obtained from incubated liver, later experiments indicate that material other than the liver may serve as a source of toxic material. Incubated blood taken from the carotid artery gave positive results in a recent experiment, and decomposed kidneys likewise have produced duck sickness symptoms.

(6) As a check against these experiments the nontoxic character of decayed liver of healthy ducks as well as of certain of the lots prepared from sick

birds (see paragraph No. 4) has been shown by experiment.

(7) The percentage of mortality among the birds made sick experimentally has been much greater than what occurs in the field. This is due partly to the excessive doses administered in early work; and partly to the fact that the great majority of sick birds brought in from the field for observation are sublethal cases. Birds given reduced doses, however, recover in the same manner and in about the same time as do those collected in the field.

(8) The faithfulness and consistency with which duck sickness symptoms are produced by this method has never been even remotely approached in any experimental work that the writer has done through the feeding of natural or synthetic alkalies.

(9) Not only have duck sickness symptoms been conveyed from the body tissues of a bird sick in the field to a healthy experimental bird by the method described, but this second bird has furnished toxic material for a third; the third in turn, for a fourth; and the fourth for a fifth. There seems to be no loss in virulence and, in fact, if any change has taken place, potency has been increased by this process.

(10) An extract of the toxic liver in normal salt solution prepared at the rate of 1 gram of decomposed liver to 5 cc of the solution, which is then filtered or allowed to settle, has permitted the injection of the toxic material into the abdominal cavity with equally typical and even more effective results. By this method material obtained from ducks has produced duck sickness symptoms in gulls, and, strange though it may seem, an extract of the incubated liver of a juvenile prairie falcon served as a means for conveying the trouble in an aberrant and mild form to a chicken and a domestic cat.

(11) Material obtained from the Bear River Marshes at Great Salt Lake has given results identical in every respect with that collected in the Klamath region.

(12) On the basis of a single experiment, it appears that boiling heat for about five minutes at this altitude (4,137 ft.) destroys the toxicity of the material.

(13) Contraction of duck sickness in the field does not establish an immunity to the symptoms as produced by this method, since birds that have recovered from duck sickness have been used two and three times in these experiments with positive results.

(14) An individual experiment performed by Mr. Sperry in 1927 in which he produced what appeared to be duck sickness symptoms by feeding liver to a duck over a period of nearly three weeks becomes explainable through the likelihood that, at some point in the feeding operations, the tissues on hand had "incubated" sufficiently in a period of hot weather.

In the foregoing the writer, an ornithologist, whom circumstances have thrust into the midst of a most baffling pathological problem, has aimed to present only such facts as have been learned from experimentation. Prudence forbids speculating at this time beyond what has actually been demonstrated, even though the results attained are highly suggestive and even though definite theories have been entertained as a help in directing the study. What has been accomplished appears to be just a beginning with much work yet to be done by specialists. Material has been gathered for histological, pathological and bacteriological studies which, as they are pursued during the coming months, may add even more startling chapters to an already intriguing subject.

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WESTERN DUCK SICKNESS AND BOTULISM

THE symptoms observed in ducks suffering from what is called "duck sickness" are characteristic of botulism as it appears in birds. Several samples of mud and water from an infected area in Tule Lake, California, were collected by one of us with the assistance of Mr. E. R. Kalmbach of the Biological Survey, during the summer of 1930, and while the outbreak of duck sickness was at its height. Bacteriological examination of the mud disclosed the presence of *Clostridium botulinum*, Type C. The primary cultures of the mud produced a toxin of rather high potency for guinea pigs (m.l.d. less than 0.001 cc for a 250 g pig); per os the m.l.d. was 0.05 cc. The m.l.d. for a domestic mallard (per os) was found to be 0.005 cc per gram of body weight.

Furthermore, *C. botulinum*, Type C, has been cultured from the tissues of wild mallards, pintails and ring-billed gulls that had died of or were killed while afflicted with "duck sickness." The clinical picture coupled with the isolation of botulinus organisms from the mud of Tule Lake and the sick birds themselves suggests that duck sickness is produced by the toxin of *Clostridium botulinum*, Type C.

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